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SEP 06 2016

EPA-REGION 10

September 6, 2016

ATTN: Harbor Comments
U.S. Environmental Protection Agency, Region 10
805 SW Broadway, Suite 500
Portland, OR 97205

Dear EPA Region 10:

We are a group of Portland Harbor Superfund Site (Site) PRPs interested in the Swan Island Lagoon portion of the Site (the "Swan Island Group"), all of whom are members of the Participation and Common Interest Group (PCIG), that have come together to comment on and propose targeted adjustments to the Environmental Protection Agency's (EPA) remedial approach for the Swan Island sediment decision unit (SDU). As described in EPA's June 8, 2016 Proposed Plan for the Site (and its June 8, 2016 Feasibility Study), the Swan Island SDU is unique and complex among the Site's SDUs. Consequently, we propose in the enclosed comments modifications that optimize the approach described in EPA's Proposed Plan in order to provide equivalent, but more efficient risk reduction in the Swan Island SDU.

Specifically, our comments ask EPA to incorporate key specific conditions of the Swan Island Lagoon and adopt a more flexible, Swan Island SDU-specific technology assignment flowchart that allows for a wider range of remedial technologies to be considered in the areas within the SI SDU that are identified for active remediation. Our approach produces an optimized remedial alternative that is equally protective of human health and the environment as EPA's Alternative I, but is better optimized to site conditions and current and future water-dependent uses, less resource-intensive, and less disruptive to Swan Island Lagoon stakeholders and neighbors.

Together, we urge EPA to adopt the Swan Island Group's optimized remedial alternative approach in its final Record of Decision.[1]

Sincerely,

Port of Portland

Daimler Trucks North America LLC

BAE Systems San Diego Ship Repair, Inc.

Cascade General, Inc.

The Marine Group, LLC

Lockheed Martin Corporation

Atlantic Richfield Company

CIL&D, LLC

Exxon Mobil Corporation (including its subsidiary and affiliate companies)

KSC Recovery, Inc.

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[1] Support for this optimized remedial approach, and any facts or conclusions contained therein, is not an admission of liability and will not be used to allocate or recover costs related to the Site.

Portland Harbor Superfund Site
Swan Island Sediment Decision Unit Optimized Remedial Alternative

Executive Summary

The following comments are submitted by the Port of Portland, Daimler Trucks North America LLC, Cascade General, Inc., BAE Systems San Diego Ship Repair, Inc., The Marine Group, LLC, Exxon Mobil Corporation (including its subsidiary and affiliate companies), Atlantic Richfield Company, Lockheed Martin Corporation, CIL&D, LLC, and KSC Recovery, Inc. (collectively, the "Swan Island Group" [1]) with respect to the Draft Final Feasibility Study (FS) and Proposed Plan (PP) for the Portland Harbor Superfund Site ("Site") issued on June 8, 2016 by Region 10 of the United States Environmental Protection Agency (EPA)[2]. These comments concern the Swan Island Sediment Decision Unit (SI SDU), a distinct and unique part of the Site. EPA acknowledges some of the SI SDU's singular qualities in the FS/PP in the remedial technology assignments for the SI SDU. While the FS/PP allows for optimization of remedies at some SDUs, and site-specific technology assignments for the SI SDU, the Swan Island Group believes that additional flexibility in applying the remedial technologies set forth in the FS/PP is appropriate for the SI SDU.

The comments identify key site-specific conditions and refinements, such as up-to-date Future Maintenance Dredging (FMD) requirements, in support of SI SDU-specific adjustments to EPA's remedial technology assignment flowcharts. The comments also address certain inconsistencies in the FS. The proposed adjustments retain and enhance the flexibility of EPA's technology assignments for the SI SDU, incorporate up-to-date data and information, and promote effective and efficient implementation of National Contingency Plan (NCP)-compliant remedial action. These adjustments will optimize the remedial alternative selected for the SI SDU, so are referred to as an "optimized" approach.

We agree with EPA that the SI SDU bears unique features and conditions. We believe the flexible framework noted earlier should provide for consideration and utilization of updated information, such additional information to be further developed during the remedial design phase. This updated information could come from multiple lines of evidence, including pilot studies, geotechnical investigations, additional sediment stability and propeller wash analyses

[1] Support for this optimized remedial approach, and any facts or conclusions contained therein, is not an admission of liability and will not be used to allocate or recover costs related to the Site.
[2] This memorandum is a joint product of Formation Environmental, Geosyntec Consultants, and Pacific Groundwater Group, as well as the signatory parties.

for capping/ Enhanced Natural Recovery (ENR)/ Monitored natural Recovery (MNR) technologies, and fish tissue and sediment sampling to determine the concentrations of chemicals of concern (COCs) throughout the SI SDU.

To effectively incorporate this updated information and optimize the remedial alternative for the SI SDU, EPA should make the following refinements in the FS/PP and, in the Record of Decision (ROD) when it is issued:

- Allow for inclusion and consideration of the following information and key site-specific conditions, such as:
  - up-to-date FMD designations and required navigational depths (based upon information provided by stakeholders operating within the SI SDU);
  - current bathymetry data in comparison to required navigation depths;
  - evidence of sediment stability in the lagoon;
  - up-to-date surface sediment polychlorinated biphenyl (PCB) concentration data;
  - effective in-place containment or treatment of Principal Threat Waste (PTW) [3]; and
  - practical source control measures.

- Add a single unified SI SDU-specific technology assignment flowchart that includes the FMD, intermediate, and shallow technology assignments.

- Consistent with the above changes, the multi-criteria decision matrix at FS Figure 3.4-16 should make clear that cap/cover technologies (e.g., Engineered Cap, Broadcast Granular Activated Carbon (GAC), ENR) can be implemented in FS-defined propeller wash areas within the SI SDU, when site investigation shows that the navigational depth is adequate to resist erosive forces from such propeller wash.

As described in the following comments, such flexibility for the SI SDU will be built into the unified technology flowchart and an optimized remedial alternative approach would be implemented during the remedial design and remedial action phase based on a series of site-specific investigations.

[3] Members of the Swan Island Group disagree with EPA's proposed designation of PTW, as explained in separate comments on the PP. Although the SI SDU optimized approach is not dependent on a change in EPA's threshold for designating PTW, the members of the Swan Island Group note for the record their position that EPA has incorrectly designated PTW. Similarly, the SI SDU optimized approach is not dependent on a change in EPA's proposed remedial action levels. Separate comments being submitted to EPA may nonetheless articulate technical and legal reasons why EPA should change them. Such comments do not, however, lessen the commitment of the Swan Island Group to the approach outlined in this memo.

This memo provides a conceptual depiction of the proposed optimized remedial alternative using updated information and compares it to EPA's Alternative I based on criteria specified in the NCP for CERCLA remedies. This analysis concludes that the optimized remedial alternative is equally protective of human health and the environment as Alternative I as presented in the FS/PP, with the optimized approach being more cost effective, more quickly and easily implemented, and less disruptive to current Swan Island Lagoon stakeholders, including neighboring communities.

1.0 Introduction

These comments describe an optimized approach for remedial action in the SI SDU at the Site. The entire SI SDU is located outside of the main channel of the Willamette River and is mostly contained in Swan Island Lagoon, a blind-end industrial slip and berthing area. Taking into account updated information on the required navigational depth in the lagoon, current bathymetry data versus navigation depth needs, considering the lagoon's acknowledged sediment stability, and additional lines of evidence with respect to surface PCB sediment and fish tissue data, and factoring in source control, we propose certain adjustments to the remedial technology flowcharts in the FS for the SI SDI. These requested changes are consistent with EPA's overall remedy logic and appropriate for the unique conditions in SI SDU and will help to correct inconsistencies in the FS report. We also believe that there should be flexibility in the application of remedial technologies during remedial design in order to address uncertainties with the Conceptual Site Model for the SI SDU. Such adjustments in the remedial technology flowcharts and flexibility in the application of remedial technologies will result in an optimized, location-specific remedial approach for the SI SDU that is NCP-compliant and provides at least equal environmental protection in a shorter time-frame.

The size and complexity of the Site have made it challenging to characterize and analyze. During the Remedial Investigation/Feasibility Study process, there was a tendency for unique areas to be sidelined given the necessity of understanding the Site as a whole. This was the case for the SI SDU, where a comprehensive evaluation is particularly important. The Site's complexity has also led to some inconsistencies and ambiguities between the text in the FS, the remedial technology assignment flowcharts presented in the FS figures, and the PP.

For example, EPA recognizes that Swan Island Lagoon requires special consideration in the assignment of remedial technologies (e.g., PP pg 32 and pg 61; FS pg ES-18), and as found in EPA's ENR evaluation of Swan Island Lagoon included in FS Appendix D (EPA 2016b). Indeed, the FS subdivides the Site into four river segments in order to evaluate attainment of the Remedial Action Objectives (RAOs), with one segment being the SI SDU (FS pg 4-2), and it states that the "subdivisions will allow for a more precise analysis of risk reduction for each alternative." However, EPA has not undertaken such a precise analysis. As a result, certain remedial technologies, such as MNR for the SI SDU, have been improperly screened out of consideration.

We agree with EPA that Swan Island Lagoon requires a more precise analysis of risk reduction. While the Site-wide screening-level FS process is not well-suited for location-specific optimization, this goal can be achieved at the SI SDU through further study and evaluation during the remedial design phase. We also recognize that some uncertainty exists with respect to the permanence and effectiveness of certain in-place remedial technologies. However, this uncertainty can be managed within EPA's framework through careful tailoring of technology assignments using the data and analysis presented here, with further refinements achieved through pre-remedial design studies and the remedial design itself.

Accordingly, in our comments we ask EPA to make certain adjustments in the ROD so as to retain and enhance the flexibility of remedial technology assignments that will be applied to the SI SDU. The requested changes to EPA's technology assignment decision flowcharts will enable future optimization of remedial technologies based on multiple criteria that include pre-remedial design studies, geotechnical considerations, detailed sediment stability and propeller wash analyses, and updated sediment and fish tissue concentration sampling data. Some key benefits of optimizing remedial technologies at the SI SDU include:

- achieving long-term risk reduction equivalent to EPA's PP, while attaining significant risk reductions over a shorter time period;
- improving cost-effectiveness and promoting efficient/sustainable use of resources, which will in turn generate broader support for implementing EPA's selected remedy;
- maintaining compatibility with water-dependent uses and navigation depths;
- addressing EPA's preference for removal of designated PTW[4];
- generating additional reductions in short term environmental and health impacts; and
- minimizing disruption to businesses that depend on access to the SI SDU.

Section 2 of this document describes the SI SDU-specific key issues, data, and assumptions that are appropriate for updating and refinement. Section 3 describes the recommended SI SDU-specific remedial technology assignment flowchart. A conceptual depiction of the optimized remedy approach using updated data is also provided in Section 3. In Section 4, the optimized remedial alternative is compared to EPA's preferred Alternative I based on criteria specified in the NCP for CERCLA remedial actions. This analysis of the SI SDU optimized approach demonstrates that it is equally, and potentially more, protective, as well as more implementable, than EPA's Alternative I.

[4] The Proposed Plan includes three categories of PTW, which EPA describes as "highly toxic PTW," "PTW source material," and "PTW that cannot be reliably contained." Per the PP, PTW within SI SDU is identified only as "highly toxic PTW."

2.0 <u>The Case for Optimizing the SI SDU Remedial Alternative</u>

In order to optimize the remedial design of SDUs, it is necessary to have an updated and improved understanding of their site-specific conditions. For the SI SDU, the most important factors to be considered are current and future land use and navigation needs in FMD areas, updated bathymetry data, and information regarding sediment stability properties, contaminant distribution and concentrations, and source control. The following summaries cover key issues in each of these areas for the SI SDU.

2.1 Updated Designation of Future Maintenance Dredge Areas and Navigational Depth Requirements

The FS/PP adopted general assumptions about future navigation uses and the need for maintenance dredging in FMD areas. The FMD areas for the Site were developed by seven parties following a 2008 vessel use survey (LWG FS 2012). EPA was not able to review that survey, but cited the need for more specificity about future harbor operations, with that evaluation to occur in the remedial design stage (FS pg 3-10 and Appendix C).

Specifically, the FS assumed that maintenance dredging would be needed to maintain navigation depths in all navigation areas:

> SMAs within the federally authorized navigation channel or designated as FMD are assigned dredging as a technology due to minimum water depth requirements, the placement of thin sand layers, in-situ treatment amendments, and conventional or reactive caps because stand-alone technologies above the established navigation dredge depth are considered incompatible with current and future waterway uses.

(EPA 2016b pg 3-10).

The Swan Island Group has obtained more specific information about current and future navigation depth requirements in the SI SDU through contacts with entities that rely on Swan Island Lagoon for water-dependent uses (*see* Attachment A). As this information makes clear, the navigation uses and depth requirements (Figure 1) differ substantially from the assumptions made in the FS and PP and demonstrate that very little ongoing navigation maintenance dredging will be necessary. Given the updated information, the following changes to the assumptions about navigation depth requirements for the SI SDU should be made:

1. Removal of the FMD designation for the head of the Swan Island Lagoon past shipyard Berth 305 and for the mouth of the lagoon outside of the SI SDU.
2. Removal of the FMD designation near the SI Shipyard Ballast Water Treatment Plant bank slope.
3. Updating of navigation depth requirements as noted on Figure 1.

This more accurate FMD information should be incorporated into a revised FS and the ROD for the Site. Details will be updated during the remedial design phase, including the navigational needs of north shore business owners where shallower depths than currently shown may be sufficient to meet ongoing navigation requirements.

2.2 Comparison of Current Bathymetry Data to Navigation Depth Requirements

Bathymetry from recent surveys in the SI SDU shows that current depths in a large portion of the area designated by EPA for dredging in Alternative I are at or greater than the navigation requirements (Figure 2). Further, the existing sediment surface is sufficiently deep that in-place technologies such as capping, ENR, or MNR could be utilized in much of the lagoon without exceeding target navigation depths for current and future uses or being adversely affected by navigation activities. In some discrete areas along specific berths, limited dredging may be needed to allow capping or placement of ENR layers if the depth of contaminated sediment were to exceed 3 feet below the mudline or on the basis of other site specific factors (e.g., geotechnical considerations, or structural offset requirements).

EPA has cited concerns that FMD could disrupt in-place remedial technologies such as caps. However, as noted by EPA in the FS, sediment deposition rates in Swan Island Lagoon are low. In fact, the last time that dredging was performed in the central portion of the lagoon for the express purpose of maintaining the depth was in the 1950s (*see* Attachment B). Other dredging occurred between 1961 and 1973, but it was primarily associated with removing material stored in the lagoon after being dredged from the Federal Navigation Channel. In addition, some localized maintenance dredging has occurred in specific berths adjacent to the Swan Island or Mock's Landing shoreline where most ship repair activity occurs. As can be seen in Attachment B, Table 1, the last maintenance dredging to occur in the lagoon was in 1986 at Berths 306, 307, and 308, with a only small amount of material (1,200 cubic yards) being removed.

The lack of maintenance dredging was not due to the absence of an entity actively managing the lagoon depths. From 1975 to 2000, the Port held a permit from the U.S. Army Corps of Engineers and Oregon Department of State Lands to conduct maintenance dredging as needed (State of Oregon, Department of State Lands, 1975-2000 Material Removal Permit No. 2080). The permit allowed for maintaining the central part of the lagoon at -30 ft. Columbia River Datum, but no dredging was necessary due to lack of significant sediment deposition.

Hydrodynamic conditions creating a very high level of sediment stability in the lagoon, as discussed below in Section 2.3, provides a useful explanation for the limited need for maintenance dredging. The Swan Island Group's recommended changes to the technology assignment flowcharts provide for these assumptions to be confirmed in the remedial design process. Details of the recommendations are presented in Section 3.1 below.

2.3 High Sediment Stability in Swan Island Lagoon

EPA recognized the stable nature of sediments in the SI SDU when it assigned ENR to Reliably Contained PTW[5] in Alternatives B-D, consistent with the FMD technology assignment decision flowchart (e.g., *see* FS Appendix D). However, EPA also stated that removal of sediments with PCB concentrations greater than 200 µg/kg (categorized as PTW) was necessary because of the perceived lack of permanence of in-place remedial technologies such as ENR and capping within the SI SDU due to concerns related to propeller wash and FMD requirements.

We agree with EPA's use of ENR applied to Reliably Contained PTW and support its use in Swan Island Lagoon, given its stable sediment environment, and we now offer to provide some technical support to EPA in clarifying where in-place remedial technologies such as ENR and caps can be used in the SI SDU. In that regard, Attachment C to this document provides a detailed summary of the data presented in the RI (EPA 2016c) and FS (EPA 2016a) that relate to the stability of sediments in the SI SDU.

The long-term sediment stability in Swan Island Lagoon is demonstrated by multiple factors documented in the RI and FS:

1. Low current velocities measured in the lagoon
2. The fine-grained nature of surface sediments
3. Stable bathymetry
4. Net accumulation of sediments at the downstream portion of the lagoon
5. Bio-geochemical conditions in the lagoon and the presence of a benthic invertebrate community.

The potential for effects on sediments from propeller wash by deep draft vessels varies greatly, depending on the size of the vessel and the depth of water. Modeling conducted for the Site (LWG 2012, Appendix Fb) and cited by EPA in the FS indicates that medium-sized ocean-going

[5] As stated above in footnote 2, with respect to EPA's designation of a 200 µg/kg PCB PTW threshold and Remedial Action Level (RAL), technical and other arguments with respect to EPA's approach are presented in separate comments by members of the Swan Island Group. While submission of this optimized approach incorporates the 200 µg/kg PTW threshold for illustrative purposes, those members of the Swan Island Group do not intend that this submission waives their opposition to that PTW threshold and RAL, or otherwise indicates a lack of support for the arguments presented in separate comments on this and other topics.

vessels, the largest expected to enter Swan Island Lagoon, cause sediment disturbance of less than one foot in depth. This suggests that cover layers more than one foot thick over the existing sediment surface would prevent disturbance of subsurface contamination in affected areas. In addition, disturbances from propeller wash are expected to be small in scale and cause localized resuspension and mixing of the surface layers. Thus the effects of propeller wash will be highly localized, can be effectively managed through remedial design, and can be monitored as necessary post-remedy. As a result, in-place remedial technologies such as ENR and capping should be considered for the SI SDU.

Given the physical stability of sediments in the SI SDU, in-place remedial technologies are comparable to dredging (i.e., removal technologies) in terms of their permanence. Further, in-place technologies limit the release of contaminants during construction as compared to the unavoidable resuspension, dissolved releases, and residuals associated with removal technologies.

2.4 Surface Sediment and Fish Tissue Concentrations Are Generally Lower than Evaluated in the Feasibility Study

Data collected during recent sampling efforts show that PCB concentrations in the SI SDU surface sediments are mostly lower than what was used in the FS evaluation (Figure 3). Twenty-six additional samples collected from 2014 to 2016 were co-located with previous sampling locations for data that were used in the FS (Geosyntec, 2016). Seventy-five percent of these samples show reduced PCB concentrations. This trend is supported by PCB concentrations measured in smallmouth bass from the SI SDU as part of a fish tissue sampling event ordered by EPA in 2012 (LWG 2013). The average PCB concentrations were are nearly seven-fold lower in fish samples than reported for the RI sampling in 2002/2007. RI fish tissue samples collected in 2002 and 2007 had a mean PCB concentration of 3,026 μg/kg, whereas the mean concentration from the 2012 sampling was 447 μg/kg.

These recent data indicate that the potential viability of natural recovery within SI SDU needs to be reassessed and, if natural recovery is confirmed to be occurring at an acceptable rate, MNR should be explicitly included in the potential remedial technologies considered for the SI SDU.

2.5 Source Control and Potential for Recontamination Must be Considered

EPA acknowledged that additional site characterization would be important to verify assumptions made in prior documents and in the development of remedial designs for the Site. The Swan Island Group agrees with this approach and believes that future sampling should be conducted to provide data to evaluate the potential for recontamination of remediated surfaces by discrete sources and/or general anthropogenic site-specific background at the SI SDU. EPA's national guidance on sediment remediation emphasizes the need for source control

(Horinko 2002) and accurate characterization of site-specific background levels (EPA 2004, 2005). An updated understanding of recontamination potential will be important at the remedial design stage in assessing the magnitude of the effort required and implications of achieving EPA's remedial goals with a sediment-only remedy in an urban waterway.

3.0 Recommendations for an Optimized Remedial Approach

Based on the key elements identified in Section 2.0, certain adjustments should be made to the remedial technology assignment process reflected in an SI SDU-specific flowchart and included in the FS and the ROD. For the most part, the proposed adjustments retain and enhance the flexibility of EPA's remedial technology assignments for the SI SDU with the goal of optimizing the remedial alternative to be selected. The combination of updating data and refining certain assumptions related to key issues such as FMD and current bathymetry and providing for increased flexibility in the technology assignments will ultimately result in an optimized remedial alternative for the SI SDU.

Key elements of the remedy and design process are as follows:

1) ***Apply a mix of remedial technologies within the RAL footprint.*** Incorporating current and future waterfront uses, required navigation depths, and other site-specific factors, in combination with adjustments to EPA's remedial technology assignment flowcharts, will result in an optimized assignment of remedial technologies. The additional remedial design investigations will further refine and inform the final cleanup design.
2) ***Apply ENR or MNR in the remainder of the SI SDU (outside the RAL footprint) to further reduce exposure and risk from PCBs and other COCs.*** Application of ENR or MNR to these areas would be evaluated for surficial PCB sediment concentrations less than the RAL. The targeted areas would be based upon results obtained through remedial design investigations.
3) ***Conduct monitoring programs to assess performance and recontamination potential to help establish long-term remedial goals.*** Monitoring programs will be necessary to measure performance of the remedy and to help determine the final remediation goals for the SI SDU.

3.1 The Technology Assignment Decision Process Should be Adjusted to Accommodate Site-Specific Conditions

Based on the SI SDU-specific considerations discussed in the preceding sections, certain adjustments to EPA's remedial technology assignment decision process for shallow (elevation above 4 feet NAVD88), intermediate (below 4 feet NAVD88), and Swan Island Lagoon FMD areas are warranted. These technology assignments are common among Alternatives B through I (EPA FS pg 3-38) and are used Site-wide. In each of these Site-wide flowcharts, EPA included decision criteria and technology assignments specifically for the unique characteristics of SI SDU. To simplify implementation of the flowcharts, we believe that EPA should create a single, unified SI SDU-specific technology assignment flowchart (shown in Figure 4). Changes to EPA's flowcharts made in preparing the SI SDU-specific flowchart are described below and correspond to red numerals on Figure 4. The rest of EPA's flowcharts were not altered in substance, but were re-formatted to fit on a single page.

The flowchart shown in Figure 4 contains the following adjustments to the concepts included in EPA's technology assignment flowcharts:

1. Replace "Broadcast GAC" with "Broadcast GAC/ENR" for intermediate regions outside the RAL and within Reliably Contained PTW boundaries. This change differentiates between areas with and without PTW and allows for carbon additions where EPA assigned ENR in Alternatives B–D. It also makes the flow chart consistent with the FS text that states: "ENR is being considered for the area in Swan Island Lagoon that is outside the SMAs to reduce risks. Where PTW is identified, treatment technologies will also be assigned" (EPA 2016b pg 3-30–3-31).

2. Replace "EMNR" with "ENR/MNR" for intermediate areas outside the RAL and outside Reliably Contained PTW boundaries. ENR may not be appropriate in areas of the basin subject to higher bottom shear velocities (e.g., such as at the mouth of the lagoon). Also, ENR may not be needed in all areas if MNR would be appropriate based on local conditions (such as COC concentrations and sedimentation rates). Depending on the different remedy components ultimately selected and the associated overall predicted Surface-Weighted Average Concentrations (SWACs), MNR may be a suitable technology in portions of the SI SDU. This is supported by the recently collected data, as described in Section 2.4.

3. Replace "Dredge to DOCR [Depth of Contamination to be Removed] with Residual Layer" to Dredge to the lesser of DOCR or adequate depth below FMD navigation depth and use the intermediate technology assignment." Use the intermediate flowchart when FMD area bottom depths are adequately (≥ 3 feet) below navigational depth. The jump from FMD to intermediate technology assignments will allow for optimal technology assignment to the remaining sediment with PCB concentrations above the RAL using the logic of EPA's multi-criteria decision matrix (EPA 2016a Figure 3.4-16) to select the best remedial technology following further design phase studies.

4. Replace "Reactive Cap" with "Reactive Cap/Broadcast GAC/ENR" for intermediate areas that designate Engineered Cap and are within Reliably Contained PTW boundaries. This change allows for flexibility in assigning the appropriate technology if an area of the SI SDU were to be "designated as Engineered Cap." We believe that if Broadcast GAC/ENR technology is applicable to Reliably Contained PTW as presented by EPA in Alternatives B–D, then it is logically consistent that the technology should also be applicable to the same areas in all alternatives, or at least retained for further consideration during remedial design.

5. Replace "Dredge to DOCR/Reactive Residual Layer" with "Dredge to the lesser of DOCR or 3 ft with Residual Layer[3]" for intermediate areas that designate "Dredge" and are within Reliably Contained PTW boundaries. Explanatory footnote # 3 states that "If DOCR is greater or equal to 3 ft apply Reactive Residual Layer."

Consistent with the above changes, the multi-criteria decision matrix set forth FS Figure 3.4-16, should clarify that cap/cover technologies (e.g., Engineered Cap, Broadcast GAC [note that although this term is used generally here, other forms may be appropriate], and ENR) can be implemented in the SI SDU FS-defined propeller wash areas when site investigation demonstrates that the navigational depth is adequate to resist erosive forces.

3.2 Maintain Flexibility in the Remedial Design Process based on a Series of Site-Specific Investigations

The proposed optimized approach described above provides flexibility in the remedial design process. The proposal is not dependent upon a change to the Alternative I RALs or EPA's definition of Reliably Contained PTW. Furthermore, it includes a series of site-specific investigations that have been and will be conducted during the remedial design phase to evaluate key assumptions and uncertainties in the RI and FS. The results will inform the design of the remedial actions and may identify the need for additional data and investigations. These could include:

a. Baseline data collection including biota, sediment chemistry (lateral extent and depth), bathymetry, and surface water data to establish the current conditions at the SI SDU, and to evaluate changes in conditions since the RI/FS. Sediment data collection would be part of an overall monitoring plan for the SI SDU and would provide a baseline to evaluate performance of the remedy.

b. Analysis of sediment stability to evaluate the permanence of ENR and the optimum thickness of ENR layers needed for the remedy. Stability analysis would include consideration of river currents and the potential for disturbance by vessel propeller wash. The analysis would build upon the previous FS evaluations.

c. Studies to identify the potential need for, and effectiveness of, *in situ* treatment with GAC or other amendments to further reduce contaminant mobility or toxicity in areas where PCB concentrations are greater than 200 μg/kg. The studies, depending on the objectives and needs, could involve field-scale efforts to determine the effectiveness of ENR or a combination of GAC amendments and ENR.

d. Studies to assess potential sources of recontamination to remediated areas and control of those sources, including storm water loading, riverbank erosion, overwater activities and other local and regional sources. These studies are needed to identify achievable remediation goals for sediment in the SI SDU. Overall results will be important for assessing the magnitude and implications for achieving EPA's long-term remedial goals with a sediment-only remedy in an urban waterway.

e. Evaluation of other conditions that provide information for the remedial design. These could include consideration of current and future waterfront activities, navigational maintenance depth requirements, and the extent of debris or other submerged material.

3.3 Optimized Remedial Alternative

The recommended approach discussed herein enhances the flexibility in remedial design to account for conditions within the SI SDU that are known today but were not taken into account by EPA in developing its remedial alternative, as well as accommodates new data and analysis that must be performed during the remedial design phase. Figure 5 presents a conceptual depiction of an optimized remedy that could result from this approach. It uses the PCB concentration data employed in the FS/PP, existing data and analyses relating to sediment stability and propeller wash, and information gathered by the Swan Island Group about navigation depth needs for current and future uses of the lagoon.

Based on the current understanding of navigation depths, areas needing additional depth would be dredged to elevations sufficiently below the required navigational depth to allow for implementation of any additional remedial technology per the adjusted technology assignment flow chart (for example 3 feet). In summary, the optimized remedy would provide for:

- dredging of sediments in the FMD to allow implementation of additional remedial technologies;
- ENR with amendments as well as armoring to protect against propeller wash in the berth areas;
- assuming that future site investigation demonstrates no adverse propeller wash impacts and thus ENR permanence, ENR with amendments (GAC, for example) in the lagoon areas away from the berths;

- dredging of sediment in dry dock areas to adequate depth and placement of a residual layer where PCB concentrations in the leave surface exceed the RAL;
- ENR with amendments in lagoon areas outside the FMD zone where PCB concentrations at the sediment surface exceed the RAL; and
- Either MNR or ENR in areas outside the PCB RAL footprint, depending on the results of sampling and other studies performed during remedial design.

4.0 Comparative Analysis of Optimized Remedial Alternative and EPA Alternative I for the SI SDU

A comparative analysis of EPA's Alternative I and the optimized remedial alternative for the SI SDU was developed on the basis of criteria specified in the NCP for CERCLA remedies. The optimized remedial alternative is described in Section 3.3 and depicted in Figure 5. See Table 1 for a comparison of some basic parameters of both approaches.

Table 1. Comparison of EPA Alternative I and Swan Island SDU Optimized Remedy

Technology Application	EPA Proposed Plan Alternative I	SI SDU Optimized Remedy
Dredging (acres)	52	24
Capping (acres)[4]	2	6
Enhanced Natural Recovery/Monitored Natural Recovery (acres)	72	66
Enhanced Natural Recovery +Activated Carbon (acres)	0[1]	34
Estimated Construction Cost ($ Million)	$236[2]	$114[2]
Construction Duration (years)	6	3
Post-Remedy PCB SWAC (ug/kg)	16[3]	14

1 Activated carbon was included in Alternative I, but details of application were not specified.

2 Total undiscounted costs presented in 2016 dollars

3 This SWAC is for Alternative E from the EPA 2015 Draft FS. Alternative E is identical to the 2016 Draft Final FS Alternative I.

4 Capping area is within the dredge footprint

4.1 Overall Protection of Human Health and the Environment Is Equivalent Under Optimized Remedial Alternative and Alternative I

The optimized remedial alternative and EPA's Alternative I would both be protective of human health and the environment in the SI SDU. The objective of both alternatives is to reduce and/or isolate PCB concentrations to the greatest extent practicable. In addition, under both alternatives SI SDU sediments having the highest PCB concentrations would be removed with all sediments in the RAL footprint being removed or capped. One primary difference between the two alternatives is that the optimized remedial alternative employs a suite of remedial technologies, including ENR with GAC or other technologies, to address portions of the sediment area with PCB concentrations that exceed the RAL. ENR and GAC have been demonstrated to effectively reduce exposure and risk from PCBs and other bioaccumulative chemical contaminants, and the PP EPA's preferred remedial alternative includes a combination of ENR and activated carbon to address sediments with PCB concentrations greater than the RAL that will not be dredged.

In the FS, EPA assessed remedy effectiveness primarily on the basis of the PCB SWAC following completion of remedy construction. EPA's overall PCB SWAC estimate in the SI SDU for Alternative I is 48 μg/kg. However, this SWAC value reflects only the effect of remediation at dredged and dredge/cap areas of Alternative I and does not account for the effect of ENR. The reasons why EPA has excluded ENR are not clear because EPA appears to consider ENR an effective remedy, as seen in the FS which states that ENR would be effective in meeting the Preliminary Remediation Goals (EPA 2016a Appendix D). Moreover, EPA explicitly accounted for the effect of ENR on SWACs in the 2015 Draft FS, where the estimated post-construction SWAC for the SI SDU for Alternative E was 16 μg/kg (EPA 2015).

The 2015 Alternative E SWAC of 16 μg/kg is a good estimate for Alternative I because the alternatives are the same for the SI SDU. The corresponding PCB SWAC for the optimized remedial alternative is 14 μg/kg. While the EPA's Alternative I and the optimized remedial alternative result in more than a 90% reduction from baseline conditions, neither SWAC value is below the PCB remedial goal of 9 μg/kg. Nevertheless, EPA indicates that residual risks for Alternative I generally meet the interim risk-based targets for evaluating overall protectiveness (1E-4 for cancer risks, and a hazard index of 10 for noncancer risks; FS Section 4.1.3). The optimized remedial alternative would also meet the interim risk-based targets based on EPA's evaluation of SWACs for the purpose of determining their effectiveness.

EPA's Alternative I includes extensive use of activated carbon to further reduce exposure and bioaccumulation of PCBs. These materials reduce the availability of the contaminant to the food chain by reducing the soluble fraction. The optimized remedial alternative incorporates ENR with potential application of activated carbon to 43 acres of the overall ENR area, thereby providing additional risk reduction by reducing bioavailability and bioaccumulation of PCBs from treated areas, which will be refined based on further remedial design studies. Activated carbon added to thin-layer sediment covers can reduce bioaccumulation of PCBs by 60 to 90% (e.g., Beckingham and Ghosh 2011; Fadaei et al. 2015). Therefore, given the high sediment stability of the SI SDU, ENR and activated carbon should be considered as active remedial technologies.

One key factor in the overall protectiveness of a remedy, as well as its long-term effectiveness and permanence, is the potential for external sources to recontaminate remediated surfaces.

Potential recontamination would affect Alternative I and the optimized remedial alternative to the same extent. Merritt et al. (2010) reviewed results for the Wycoff/Eagle Harbor (Washington), Ketchikan Pulp (Alaska), and Bremerton Naval Complex (Washington) sites and found that the primary condition adversely affecting post-construction SWACs was lack of source control and subsequent deposition of contaminated sediments on the surface of all remediation technology types, including thin layers, engineered caps, and dredged areas. Therefore, long-term success of sediment remedies relies on source control and reducing external sources of contamination. Equally important for urban/industrial settings, evaluating the success of sediment remediation also must incorporate an understanding of the uncontrollable sources of contamination that result in anthropogenic background.

Lastly, the residual risk associated with fish consumption is similar in the case of EPA's Alternative I and the optimized remedial alternative. EPA projects that fish tissue PCB concentrations exceed acceptable risk thresholds under background conditions for the key exposure scenarios it selected (i.e., subsistence and high-frequency fishers). Based on EPA's baseline risk assessment, even one 8-ounce fish meal per month would lead to PCB exposures that exceed EPA's risk thresholds (i.e., corresponding to 1E-6 cancer risk, or greater) under background conditions. Because EPA policy dictates that sediments cannot be remediated to levels below background, no functionally significant increase in fish consumption can be achieved for EPA's target receptors as a result of remediation under Alternative I or the optimized remedial alternative.

4.2 Long-Term Effectiveness and Permanence is Provided for Under Optimized Remedial Alternative and Alternative I

EPA's primary reason for utilizing more extensive dredging is that removal is a more permanent remedy than capping or covering in place using ENR or *in situ* treatment. However, this reasoning does not adequately consider the high sediment stability conditions in the SI SDU. EPA's Sediment Remediation Guidance cites sediment stability as a key factor in remediation technology assignment (EPA 2005). Under conditions of stable sediments, in-place remedies such as ENR, *in situ* treatment, and capping are as permanent as dredging for all practical purposes. Furthermore, as discussed above, thin-layer remedial actions such as ENR have been shown to be effective in isolating or reducing surface concentrations at other sediment remediation sites within EPA Region 10. For example, incorporating ENR in the Site would be consistent with EPA Region 10's ROD for the Lower Duwamish Waterway (EPA 2014) where EPA designated a PCB upper concentrations limit of approximately 36,000 to 195,000 µg/kg for use of ENR (subtidal Recovery Area 2, Table 28, LDW ROD). Furthermore, EPA made this technology assignment decision for the Lower Duwamish Waterway based on a projected ENR layer of 6 to 9 inches, which is thinner than the 12-inch layer projected for the SI SDU.

The Swan Island Group conducted a focused evaluation of sediment stability for the SI SDU (Attachment C). As noted by EPA in the FS, sediment in the SI SDU is very stable with a net deposition environment throughout the SDU, very low river currents (especially in the most contaminated areas), and very low sediment deposition rates. As discussed in Sections 2 and 3 above, mudline elevations meet navigation requirements for most of the lagoon that has such depth requirements. In these areas, in-place remedies can be applied without the risk that FMD will disrupt the applied technologies. Berth areas where maintenance dredging may be needed will likely be addressed with dredge/cap remedial technologies installed below FMD depths to accommodate future operations.

Propeller wash from vessels is also an important factor to consider. However, analysis using models recommended by EPA (*see* Attachment D), information on the types of ships that enter Swan Island Lagoon, and the required navigational depths, indicates that propeller wash from most vessels would disturb only the upper 6 inches of sediment and that disturbance from any vessel anticipated to use the lagoon should be less than 12 inches. Because the entire area in Swan Island Lagoon subject to large vessel traffic will be covered with a minimum 1-foot sand layer, existing sediments, or the new surfaces exposed by dredging would not be disturbed. During the remedial design phase, an appropriate safety factor for cap, ENR layer thicknesses could be calculated, as necessary, to minimize the risk of exposing underlying sediments due to propeller wash.

4.3 Equal Reduction of Toxicity, Mobility, or Volume through Treatment is Provided for Under Optimized Remedial Alternative and Alternative I

Both the optimized remedial alternative and Alternative I include the use of activated carbon in the sand cover to reduce the mobility and bioavailability of PCBs and other organic COCs. In the FS, EPA provided no quantitative evaluation of the effect of activated carbon on reducing PCB concentrations in fish tissue, and no criteria for evaluating the effectiveness of the remediation. As noted above, research publications and pilot studies conducted at other sites indicate that adding activated carbon results in more than a 90% reduction in PCB concentrations in pore water and more than an 80% reduction in PCB uptake by fish (Sun and Ghosh 2007; Ghosh et al. 2011; Fadaei et al. 2015). This represents a significant reduction in mobility, bioaccumulation, and toxicity of sediment contamination. In addition, the FS identifies activated carbon or other amendments as treatment-based technologies for PTW that can be reliably contained to reduce contaminant bioavailability. EPA has designated PTW in SI SDU as reliably containable.

4.4 Optimized Remedial Alternative Has Greater Short-Term Effectiveness

As previously discussed, the optimized remedial alternative for the SI SDU entails less dredging and larger areas of ENR as compared to EPA's Alternative I. Remedial construction operations in the SI SDU are constrained by the in-water work windows designated to protect migrating salmon, operations of governmental entities and businesses on Swan Island and in Mock's Landing, and the availability of dredging equipment in the region. Estimates to implement Alternative I are about six years. The SI SDU Work Group estimates that the optimized remedial alternative will require three years to complete. The shorter time span for completion of the optimized remedial alternative represents substantially less disruption of business operations in the SI SDU and reduced impact on the aquatic environment. Further, because smaller volumes are associated with the optimized remedial alternative, the impacts on the community and project construction workers will be less than those that would occur under EPA's Alternative I. For these reasons, the optimized remedial alternative for the SI SDU has greater short-term effectiveness than EPA's Alternative I.

4.5 Optimized Remedy Alternative Is Easier to Implement than Alternative I

The technologies proposed for both Alternative I and the optimized remedial alternative are implementable and have been demonstrated at other Superfund sites. However, the optimized remedial alternative has a shorter estimated in-water construction duration (three years versus six years). Given that the SI SDU includes an operating port, existing commercial operations will be adversely impacted by in-water remedial activities. Conversely, the effectiveness of in-water remedial activities will be adversely impacted by commercial operations, resulting in remedial operational efficiencies of much less than the 90% assumed by the EPA. Therefore, a shorter construction duration will substantially minimize potential impacts to commercial operations and thus improve the implementability of the remedial action.

According to the PP, portions of the shoreline will undergo remediation of the bank area. Due to the river-dependent uses of river frontage properties, banks are typically steepened beyond the angle of repose associated with native soils and sediments, with that angle maintained by means of extensive arrays of pilings, riprap, or bulkhead and overwater structures. A large percentage of the SI SDU contains overwater structures (*see* FS Figure 3.4-23). The combination of over-steepened slopes with buildings and other structures in close proximity to the top of the river bank all but rules out any form of dredging or excavation along these shorelines. Where such work is still possible, it would be much more expensive and time-consuming than typical open-water dredging.

4.6 The Optimized Remedial Alternative Is More Cost Effective than Alternative I

The estimated capital cost of the optimized remedial alternative for the SI SDU is approximately $114 million whereas the estimated capital cost of implementing EPA's Alternative I in the SI SDU is approximately $236 million (both estimates use EPA's assumptions on areas, volumes, unit rates, indirect costs, and contingencies; Formation 2016). Assuming the alternatives have the same level of environmental protection, as is shown by the analysis above, the optimized remedial alternative is clearly more cost effective.

5.0 References

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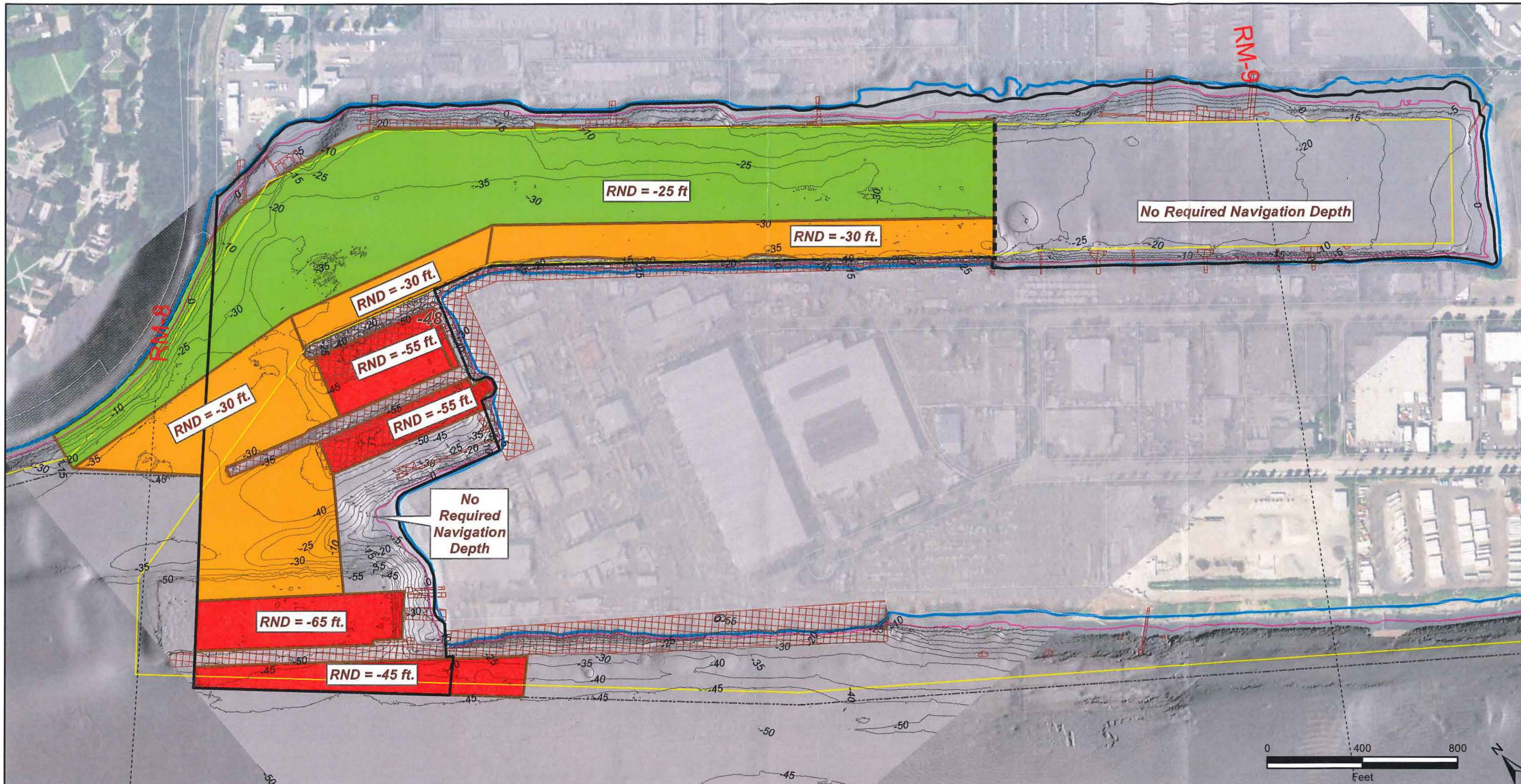

Merged Bathymetry (2015, 2009, 2004) CRD contour (5-ft)	Required Navigation Depth (RND, 2016)
SDU	**Required Navigation Depth Categories (RND, 2016)**
Harborline	-20 to -25 ft
Willamette River Federal Navigation Channel	-30 to -36 ft
River Miles	-45 to -65 ft
OLWL (6.9 NAVD88; 1.7 CRD [@T4])	
Waterfront Taxlots (2010)	
Dock Structures (LWG, 2007)	
OHWL (20.1 NAVD88; 14.9 CRD [@T4])	

Notes:
- Based on Required Navigation Depths (RND, 2016)
- Merged Bathymetry (2015, 2009, 2004), 2014 Aerial Image
- "RND" = Required Navigation Depth

This more accurate FMD information should be incorporated into a revised FS and the ROD for the Site. Details will be updated during the remedial design phase, including the naviational needs of north shore business owners where shallower depths than currently shown may be sufficient to meet ongoing navigation requirements.

FIGURE 1

OVERWATER STRUCTURES AND UPDATED REQUIRED NAVIGATION DEPTH (SHOWN BY FACILITY), SWAN ISLAND SEDIMENT DECISION UNIT

DATE: AUG 31, 2016

BY: CRL/DLL | FOR: AKC

FORMATION ENVIRONMENTAL

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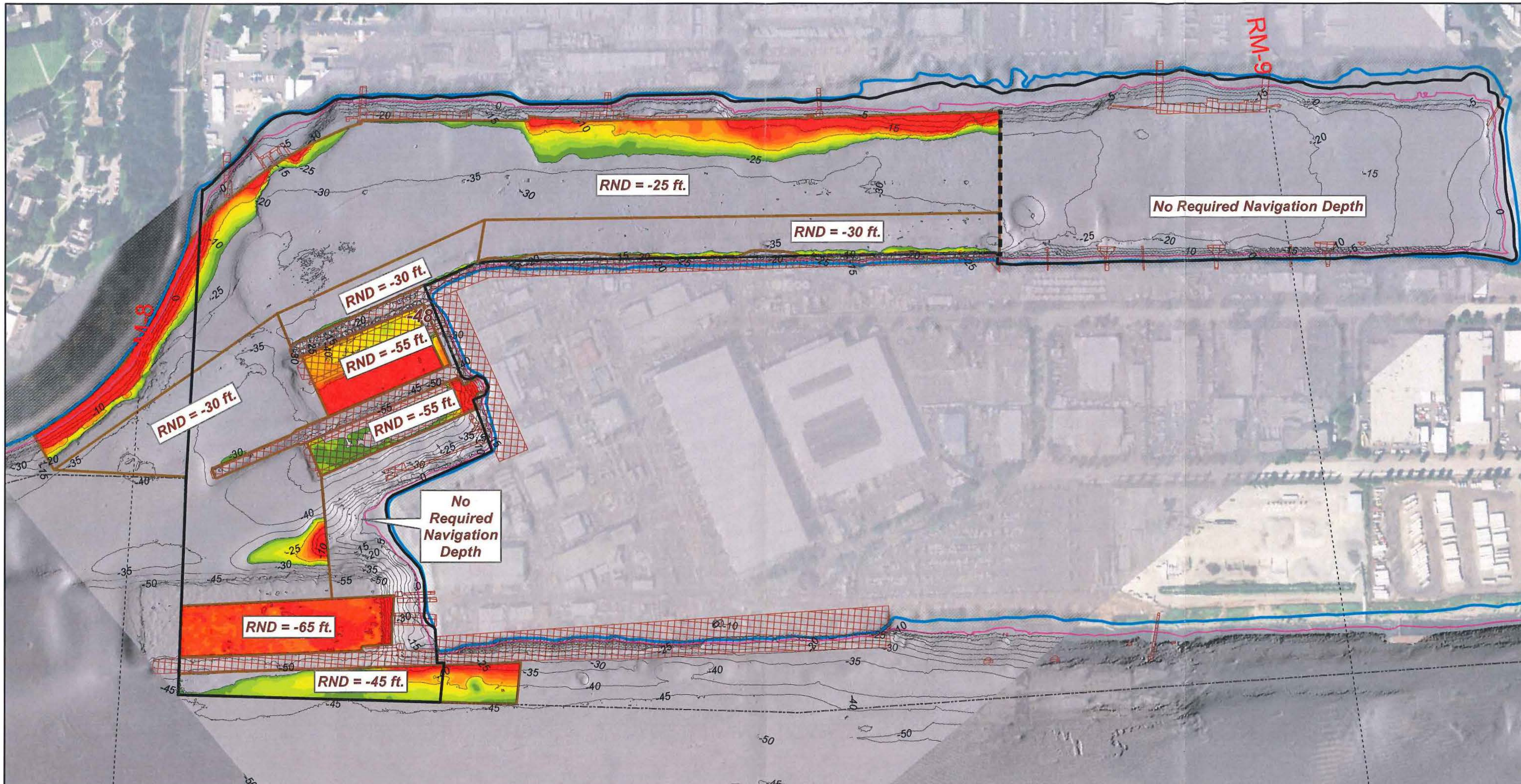

Merged Bathymetry (2015, 2009, 2004) CRD contour (5-ft)
SDU
Willamette River Federal Navigation Channel
River Miles
OLWL (6.9 NAVD88; 1.7 CRD [@T4])
Dock Structures (LWG, 2007)
OHWL (20.1 NAVD88; 14.9 CRD [@T4])
Required Navigation Depth (PND, 2016)

Estimated Dredge Thickness (feet) to get from merged bathy to RND elevation

11 - 36
10
9
8
7
6
5
4
3
2
1

Notes:
- Based on Required Navigation Depths (RND, 2016)
- Merged Bathymetry (2015, 2009, 2004)
- 2014 Aerial Image
- "RND" = Required Navigation Depth

0 250 500
Feet

N

FIGURE 2

AREAS OF THE SWAN ISLAND SDU THAT ARE ABOVE REQUIRED NAVIGATION DEPTHS

DATE: AUG 31, 2016
BY: CRL/DLL FOR: MCL

FORMATION ENVIRONMENTAL

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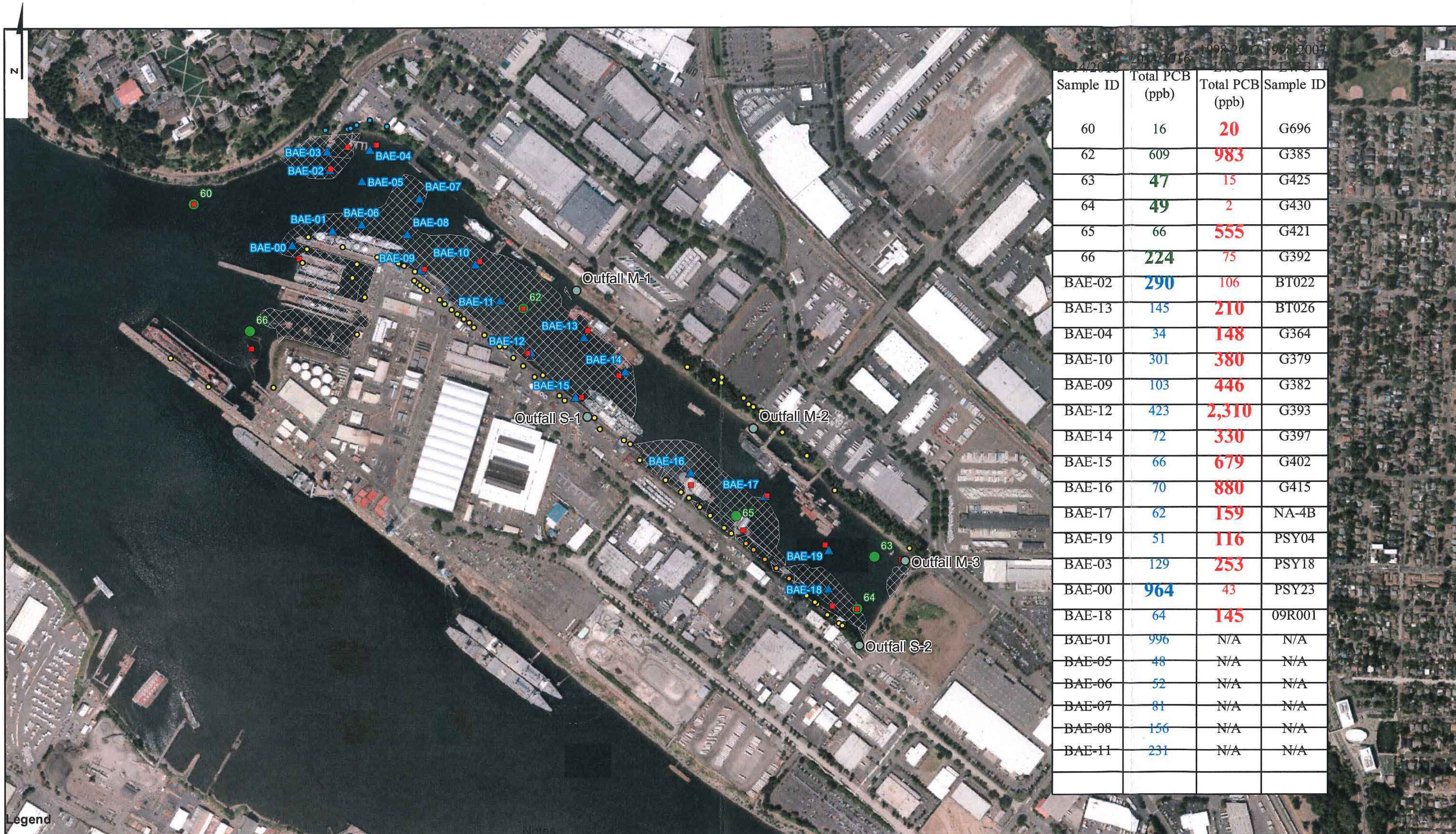


2014/2016 Sample ID	2014/2016 Total PCB (ppb)	1998-2007 LWG Total PCB (ppb)	1998-2007 LWG Sample ID
60	16	20	G696
62	609	983	G385
63	47	15	G425
64	49	2	G430
65	66	555	G421
66	224	75	G392
BAE-02	290	106	BT022
BAE-13	145	210	BT026
BAE-04	34	148	G364
BAE-10	301	380	G379
BAE-09	103	446	G382
BAE-12	423	2,310	G393
BAE-14	72	330	G397
BAE-15	66	679	G402
BAE-16	70	880	G415
BAE-17	62	159	NA-4B
BAE-19	51	116	PSY04
BAE-03	129	253	PSY18
BAE-00	964	43	PSY23
BAE-18	64	145	09R001
BAE-01	996	N/A	N/A
BAE-05	48	N/A	N/A
BAE-06	52	N/A	N/A
BAE-07	81	N/A	N/A
BAE-08	156	N/A	N/A
BAE-11	231	N/A	N/A

Legend

- Colocated Sample Location with LWG RI/FS
- 2014 Kleinfelder Sample
- 2016 Geosyntec Sample
- Estimated EPA Remedial Alternative I Area

Outfalls

- Private
- City of Portland
- Port of Portland
- US Coast Guard

Notes

1. Aerial imagery was taken in the summer of 2014 and downloaded from the City of Portland ArcGIS MapServer.
2. In the table, colored text denotes total PCB concentrations (ug/kg):
   Geosyntec Sample
   Kleinfelder Sample
   LWG RI/FS Sample

Surface (0-30 cm) Sediment Sampling Results

Portland, OR

500 250 0 500 Feet

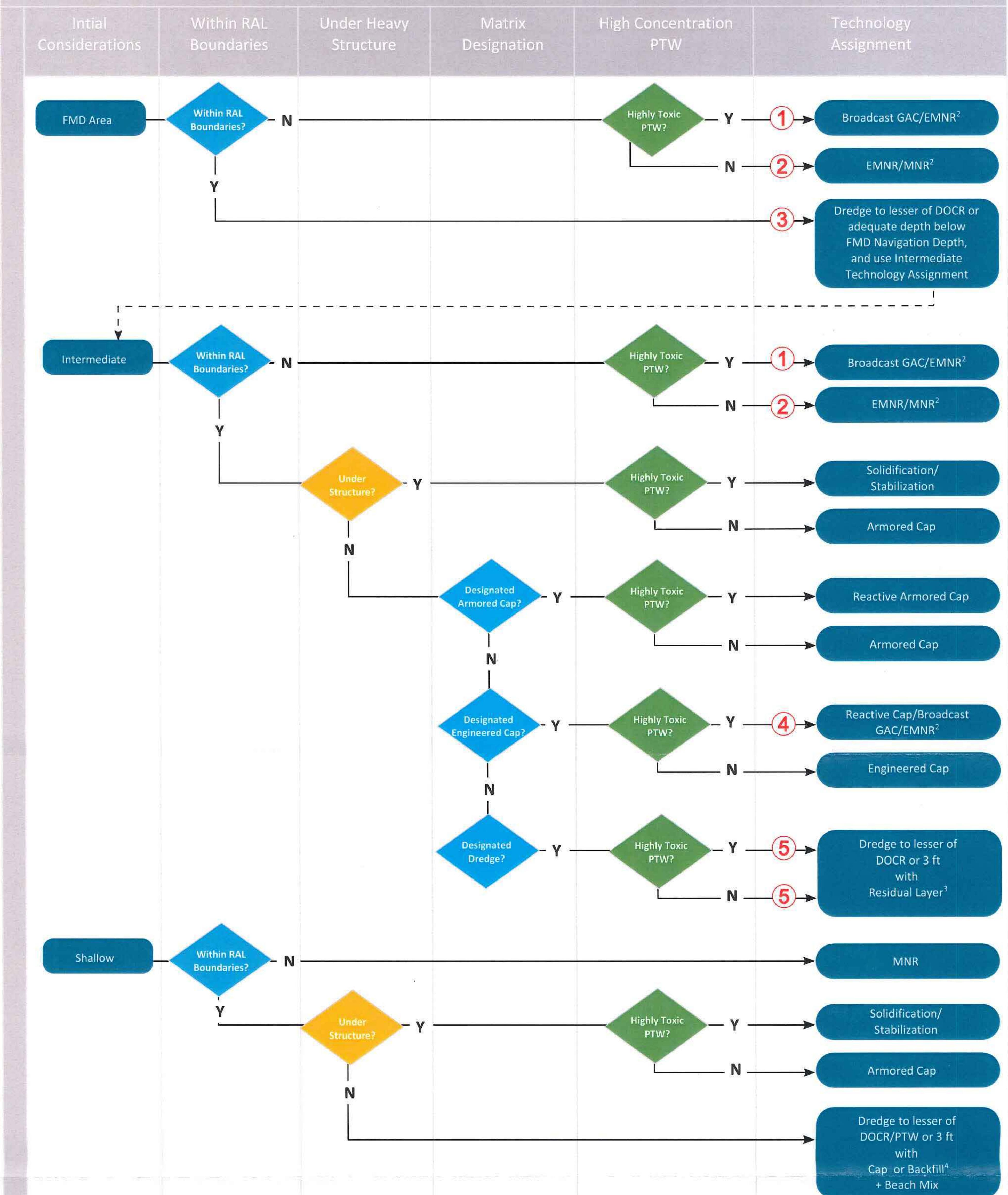
Geosyntec consultants

Portland, OR June 2016

Figure 3

Portland Path: P:\GIS\Projects\BAE_Systems\Projects\FigureX_SampleTPCB_Results_2016 Tabloid v10.0.mxd

Figure 4: Technology Assignments for Swan Island SDU



See accompanying text for explanation of revisions identified by red numerals.

Notes:

All Concentrations greater than RAL alternative are less than 18 feet deep in the FMD and 15 feet in the Navigation Channel. The diagram is based on the assumption that no PTW or sediment concentrations are found below these depths.

(1) See Section 3.3.3.5 for explanation of not reliably contained PTW.

(2) In the Swan Island SDU, matrix designation and subsequent technology assignments will be determined based on remedial design studies

(3) If DOCR is greater or equal to 3 ft apply Reactive Residual Layer.

(4)DOCR/PTW > 3 ft use Reactive Engineered Cap, PTW < 3 ft, DOCR > 3 ft use Engineered Cap, or DOCR/PTW < 3 ft use Backfill.

DOCR – Depth of contamination to be removed based on Remedial Action Levels (RALs)

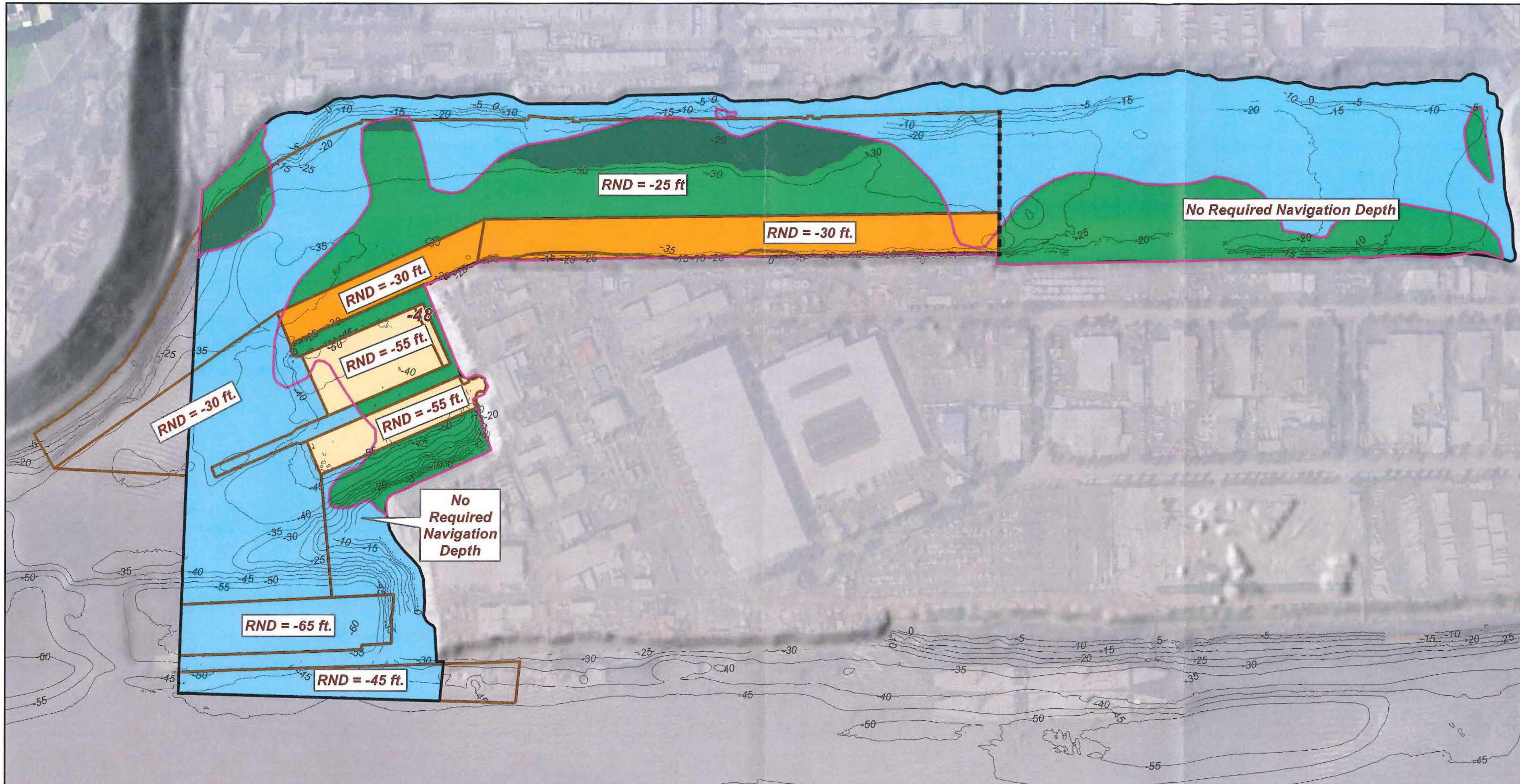
EMNR – Enhanced monitored natural recovery

FMD – Future maintenance dredge

MNR – Monitored natural recovery

Nav – Navigation channel

PTW – Principal threat waste



- 2009 CRD contour (5-ft Index)
- EPA Alternative I dredge footprint
- Swan Island Sediment Decision Unit
- 2016 Potential FMD (Adapted from AQ_LWG_toEPA May, 2012)

Technology

- Dry Dock Basins: Dredge to Adequate Depth Below Required Navigation Depth, Residual Layer
- ENR / MNR (areas to be determined in design)
- Enhanced Natural Recovery (ENR) + Activated Carbon (AC)
- FMD Dredge + ENR + AC
- FMD Dredge + ENR + AC + Armoring

Notes:
- Based on Potential Future Maintenance (PFM) Dredge Depths (2016 updates). [Adapted from AQ LWG to EPA May, 2012]
- 2009 Bathymetry/Contours, 2014 Aerial Image
- "RND" = Required Navigation Depth

FIGURE 5

EXAMPLE
TECHNOLOGY ASSIGNMENTS
SWAN ISLAND SDU OPTIMIZED REMEDY

DATE: AUG 31, 2016
BY: CRL/DLL FOR: MCL

FORMATION ENVIRONMENTAL

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Swan Island SDU

Optimized Remedial Alternative

Attachment A

Attachment A: SIL Waterfront Use and Future Maintenance Depth Requirements

Purpose

To present information on waterfront-dependent businesses in Swan Island Lagoon and on the type of current and future uses and to use this information to evaluate future navigational depth needs.

Approach

Multnomah County Assessor tax lot information as of 4/15/2016 was obtained by the Port of Portland (Port). Tax lots that are adjacent to the waterfront (or are otherwise associated with a waterfront tax lot) in and around Swan Island Lagoon and the Shipyard were plotted in GIS and mapped on Figure 1. The following Assessor data are included in Table 1:

- Tax Lot ID
- RNO #
- Tax Lot (Site) Address
- Current Owner

Table 1 was supplemented to include information on operations, waterfront structures and usage, and where applicable, the required navigational depth for active waterfront uses. Supporting references are also provided. The following summary describes the process used to populate the additional fields.

1. Review of the operation (business) type on each tax lot was performed using publicly-available information and the results were included in the table. Publicly-available information included Multnomah County records, telephone indices, and company websites.

2. The presence of waterfront structures was documented for each tax lot based on known information and aerial photographs.

3. Where a waterfront structure was present, its water-dependent use was verified. The sources of information used to confirm a tax lot's waterfront use consisted primarily of Port staff correspondence with the business owner/operator. One exception is the U.S. Navy, where outreach has been initiated but is not complete. Citations for the communications are included.

4. Information regarding the required navigational depth for the active waterfront structures was obtained and is included in the table. The source of this information is Port staff correspondence with the business owner/operator. Citations for the communications are included.

Findings

All of the waterfront structures in and around Swan Island Lagoon are active except for two berths: Berth 308 on Swan Island, and former Berth 311 in Mocks Landing. *See* Table 1. These two berth areas are located toward the upstream end of the Lagoon. Neither of these berths are currently in use, and no future uses are anticipated.

Overwater structures and corresponding navigational depths (where applicable) are shown in Figure 2 and summarized by facility as follows.

1. Vigor Industrial Shipyard
   a. Lagoon-Side Berths 301–305—berths are active for layup/ship repair. Current depth is adequate for operations at -30'.
   b. Lagoon-Side Berths 306–307—no operational depth is required at this time.
   c. Dry Dock Basin on the north side of Swan Island—Operational depth for the basins for Dry Docks 1 & 3 is -55'.
   d. Vigorous Dry Dock Basin on the north side of Swan Island—operational depth is optimal at -65'; however, while this feature is located within an applicable tax lot, the structure is outside of the SI SDU.
   e. Willamette River Side Berths—while included in the tax lot, these structures are outside of the SI SDU.

2. Port Dredge Base—mooring barges used for maintenance and moorage of dredge and attendant equipment; operational depth is -25'.

3. Marine Salvage Corporation/Fred Devine Diving & Salvage—dock structure is used for moorage and loading vessels; operational depth is -22'.

4. U.S. Navy—pier used for occasional shallow-draft vessel moorage; no operational depth requirements are anticipated.

5. U.S. Coast Guard—dock for moorage of the USCG Bluebell; operational depth is -12.65'.

Attachments

Tables

- Table 1: Swan Island SDU Waterfront Ownership and Navigation Depth Requirements.

Figures

- Figure 1: Waterfront Tax Lots Surrounding Swan Island Lagoon and Shipyard.
- Figure 2: Overwater Structures and Updated Navigation Depth Requirements (shown by facility) (provided as Figure 1 of the main document).

Attachment A
Table 1. Swan Island SDU Waterfront Ownership and Navigation Depth Requirements

Map ID	Tax Lot ID[1]	RNO#	Site Address	Owner	Operator	Operation	Are waterfront structures present?	Is there a water-dependent use?	If yes, what is waterfront usage?	Source of Waterfront Usage Information	Required Nav Depth	Source of Nav Depth Information
0	1N1E17-00301	R649840290	5555 N Channel Ave	Shipyard Commerce Center LLC	Vigor Industrial	Ship repair	Yes	Yes	Dry docks and berths for ship repair	Vigor Industrial	Berths 301-305: -30' Berths 306/307 - None at this time	Meeting with Alan Sprott (Vigor) on 3/10/216; email from Alan Sprott (Vigor) to Kelly Madalinski (Port of Portland) on 4/11/2016; email from Alan Sprott (Vigor) to Dwight Leisle (Port of Portland) on 8/9/2016
1	1N1E17B-01100	R941170940	6735 N Basin Ave	United States of America	U.S. Naval Reserve	U.S. Navy & U.S. Marine Corps training center and administrative offices	Yes	Yes	350' pier used for occasional shallow-draft vessel moorage	U.S. Navy	None at this time	Email from Jennifer Sullivan (NAVFAC NW) to Dwight Leisle (Port of Portland) on 8/18/2016
2	1N1E17B-01200	R941170920	6767 N Basin Ave	United States of America	U.S. Coast Guard	Marine Safety Office (search & rescue, enforcement, navigation aid)	Yes	Yes	Berth for moorage of the CGC Bluebell	Email from Dennis Mead (USCG) to Fred Meyer (Port of Portland) on 3/1/2016	12.65'	Email from Dennis Mead (USCG) to Fred Meyer (Port of Portland) on 3/1/2016; call between Dwight Leisle (Port of Portland) and Ana Barboza (USCG) on 8/5/2016
3	1N1E20-01900	R941201320	5555 W/ N Channel Ave	Shipyard Commerce Center LLC	Vigor Industrial	Ship repair	Yes	Yes	WR side berths for ship repair	Vigor Industrial	N/A - not in SDU	
4	1N1E20A-00402	R649755370	5036 N Lagoon Ave	Anchor Park LLC	William E. Scarborough Jr.	Vacant land - unknown use	No	No		Aerial photographs and Mult Co. Assessor data		
5	1N1E20A-00403	R649867690	3737 N Emerson St	City of Portland	BES Facilities/Admin Services	Parking lot for boat ramp	No	No		Aerial photographs and Mult Co. Assessor data		
6	1N1E20A-00404	R649867700	N Basin Ave	City of Portland	BES Facilities/Admin Services	Public boat ramp	Yes	Yes	Public boat ramp	https://www.portlandoregon.gov/bes/article/579568	N/A	Fred Myer (Port of Portland)
7	1N1E20AB-00100	R941200920	5160 N Lagoon Ave	Freightliner	Daimler Trucks North America	Truck manufacturing	No	No		Aerial photographs and comments from Janet Knox (Daimler's consultant)		
8	1N1E20AB-01603	R649840300	5420 N Lagoon Ave	Port of Portland (Leased)	R C Display Vans Inc.	Commercial vehicle outfitters	Yes	No		Port of Portland	None at this time	Email from Fred Meyer (Port of Portland) to Kelly Madalinski (Port of Portland) on 2/23/2016
9	1N1E20AB-01606	R649840324	5420 N Lagoon Ave	Port of Portland (Leased)	R C Display Vans Inc.	Commercial vehicle outfitters	Yes	No		Port of Portland	None at this time	Email from Fred Meyer (Port of Portland) to Kelly Madalinski (Port of Portland) on 2/23/2016
10	1N1E17CA-00400	R941171120	6208 S/ N Ensign St	Port of Portland	Navigation Dept - Dredge Base	Base of operations for Navigation Department	Yes	Yes	Mooring for dredge, barges, and equipment	Port of Portland	25'	Email from Doyle Anderson (Port of Portland) to Kelly Madalinski (Port of Portland) on 3/2/2016
11	1N1E17CA-00500	R941171030	6208 N Ensign St	Port of Portland	Navigation Dept - Dredge Base	Base of operations for Navigation Department	Yes	Yes	Mooring for dredge, barges, and equipment	Port of Portland	25'	Email from Doyle Anderson (Port of Portland) to Kelly Madalinski (Port of Portland) on 3/2/2016
12	1N1E17CA-00600	R941171010	6211 N Ensign St	The Marine Salvage Consortium	Fred Devine Diving & Salvage	Vessel salvage	Yes	Yes	Dock for moorage and loading of vessels	Marine Salvage Corporation	22'	Call on 8/4/2016 between Mr. Mick Leitz (President of MCS) and Dwight Leisle (Port of Portland).
13	1N1E17D-01901	R649670370	5949 N Basin Ave	Becker Land LLC	Becker Trucking	Transportation company	No	No		Becker Trucking LLC		
14	1N1E17D-01902	R649670380	N Basin Ave	Becker Land LLC	Becker Trucking	Transportation company	Yes	No		Becker Trucking LLC	None at this time	
15	1N1E17D-02100	R941171260	5617-5885 N Basin Ave	North Basin Watumull LLC	Northwest Paper Box	Corrugated box manufacturer	No	No		Aerial photographs		
16	1N1E17D-02200	R941171290	6135 N Basin Ave	ATC Leasing Co LLC	Automotive Carrier Services	Transportation company	No	No		Aerial photographs		
17	1N1E17D-02300	R941170520	6147 N Basin Ave	ATC Leasing Co LLC	Automotive Carrier Services	Transportation company	No	No		Aerial photographs		
18	1N1E18D-00200	R941180390	5555 W/ N Channel Ave	Shipyard Commerce Center LLC	Vigor Industrial	Ship repair	Yes	Yes	Dry docks and berths for ship repair	Vigor Industrial	Dry Docks 1 & 3 - 55' Vigorous Dry Dock - 65'	Dry Docks 1 & 3 - Port meeting w/ Alan Sprott (Vigor) on 3/10/2016; email from Alan Sprott (Vigor) to Kelly Madalinski (Port of Portland) on 4/11/2016 Vigorous - ERM, 2010 Sediment Characterization Report
19	1N1E18A-00100	R941180010	5000 N Willamette Blvd	University of Portland	University of Portland	Educational institution	No	No		Aerial photographs		

Notes:
[1] Tax Lot information from Multnomah County dated 4/15/2016

Legend

Waterfront Tax Lots

Oregon tax lot ID numbers are labeled.

0 500 1,000
Feet

FIGURE 1

WATERFRONT TAX LOTS SURROUNDING SWAN ISLAND LAGOON AND SHIPYARD

DATE: SEP 01, 2016

BY: DLL | FOR: SAM

FORMATION ENVIRONMENTAL

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Swan Island SDU

Optimized Remedial Alternative

Attachment B

Attachment B: SIL Dredge History Summary

Purpose

Information regarding the history of dredging in Swan Island Lagoon (SIL) is provided to support the evaluation of sedimentation and requirements for future maintenance dredging (FMD) in SIL.

Approach

Using the Port of Portland's historical dredge/fill records, events related to dredging in SIL or the entrance to the Lagoon are listed in Table 1 and summarized as follows:

1. The type of dredging for each event is categorized as one or more of the following:
    a. Deepening
    b. Maintenance dredging
    c. Construction dredging
    d. Rehandling (i.e., relayed material)
    e. Erosion control
2. Where available, volumes of material are included
3. Where known, dredge depths are included in notes

Findings

SIL is a constructed feature that was created in the 1920s when a causeway was built to connect the island to the mainland (effectively creating a peninsula). The lagoon is a quiescent environment that is not subject to the normal flows of the Willamette River and as such, the rate of sedimentation or introduction of sediment to the lagoon is low. This conclusion is supported by the dredging history, which shows infrequent historical need for maintenance dredging. When maintenance dredging did occur, it took place either in the vicinity of the approach to the lagoon or at discrete berths and docks.

A summary of key findings from the review of the dredge history follows.

1. Initial dredging to deepen the lagoon likely occurred in the early 1940s in connection with the construction of the Kaiser Shipyard for the United States during WWII; however, records from that time period do not provide sufficient details to confirm where dredging occurred within the SIL, or to what depth. These initial dredging events are not included in the table.

2. The earliest documented deepening of the lagoon was in 1951 and was likely associated with the conversion of the downstream end of Swan Island to a ship repair yard.

3. Following the 1951 deepening, maintenance dredging of the approach to the lagoon and areas adjacent to Berths 301–305 was performed in 1955, 1956, and 1957. The 1950s were the last

time dredging was performed that may have covered the central portion of the lagoon for the express purpose of maintaining the depth. The entrance to the lagoon was also dredged in 1971 to a depth of -35', although it is unclear if that was related to channel deepening or channel maintenance.

4. Beginning in the 1960s, the lagoon was used as a "relay" location for rehandling material dredged from other locations, mainly channel deepening and maintenance in the main channel of the Willamette River. Sediment dredged from the channel was pumped into the lagoon until it could be repumped into Mocks Landing or the end of the lagoon for use as fill material. Between approximately 1961 and 1973,[1] dredge material was periodically transferred into the lagoon and later redredged and pumped into adjacent upland areas. Records show that the rehandling largely occurred at the upstream end of the lagoon, which is now filled land. This is likely due to the fact that the area had less activity and vessel traffic than the downstream part of the lagoon.

   As shown on Table 1, the rehandling activities make up the majority of the volume of material dredged from the lagoon over time. One thing that is unclear, however, is if the lagoon was maintained to a certain depth by virtue of the rehandling. In other words, it is not clear if the lagoon was over dredged at the time of rehandling to accomplish the needed depth at the same time.

5. Other dredging events in the lagoon were focused on nearshore areas at berths and docks, both for construction and for maintenance. Table 1 shows that the last maintenance dredging that occurred in the lagoon was in 1986 at Berths 306, 307, and 308, with a small amount of material (1,200 cubic yards) removed.

6. From 1975 to 2000, the Port held a joint permit issued by the Corps and DSL that covered annual maintenance dredging at all of its properties with waterfront uses. Along with lagoon berths at the Shipyard, the permit consistently showed, and allowed for, maintenance dredging in the middle of the lagoon to -30 feet. However, based on documentation of dredging activities, it appears that lagoon maintenance was simply allowed under the permit, but was never performed.

<u>Considerations</u>

- Private dredging may not be accurately represented in the table. For example, Fred Devine reported that it conducted maintenance dredging at its dock in 1973, which is not depicted in the table.

[1] In 1974, a berm was constructed across the end of the lagoon to facilitate filling of that area. Material was either pumped or brought in by barge to complete the fill.

Attachment B

Table 1 - Swan Island Lagoon Dredging History

Parties Involved	Year	Dredged Area	Approx Volume (cubic yards)	Filled Area	Dredging Type	Dredge Depth (where available)
USACE Port of Portland	1951	Swan Island Basin Dredging Channel	568,715 ?	Mocks Landing - roadway fill along east bank of Swan Island Basin/Mocks Landing property acquired from Multnomah County	Lagoon Deepening	
USACE Port of Portland	1953	North end of Swan Island/entrance to Swan Island Basin	743,830 ?–1,676,880 ?	Mocks Landing - Areas A, B, and C; SW corner of Port Property north of section line, and Former Lagoon or Port Center area	Rehandling	
USACE Port of Portland	1955	Relay dumps near the upstream and downstream ends of Swan Island	392,642 ?	Mocks Landing	Rehandling	
USACE Port of Portland ?	1955	Downstream end of Swan Island (approach to dry docks and lagoon)	104,674 ?	Mocks Landing shore and parking lot	Maintenance Dredging	
USACE Port of Portland	1956	Channel approach to Dry Docks; PSRY Berths 1 and 2 - Port job 1315	149,482 ?	Mocks Landing - Area A (Area 5) (Kaiser Parking Lot)	Maintenance Dredging	
USACE Port of Portland	1957	Downstream end of Swan Island Basin adjacent to Swan Island outfitting dock berths 4 and 5 - Port job 1322	120,684 ?	Mocks Landing - Area A (Area 5) (NW of Kaiser Parking Lot)	Maintenance Dredging	
USACE Port of Portland Forest Investment Co.	1961	Swan Island Basin (pick up from relay)	58,000 ?–70,254 ?	Mocks Landing - Old Kaiser Parking area	Rehandling	
General Construction Port of Portland	1962	PSRY - Berths 306, 307, 308	12,420	Swan Island Lagoon (In-water directly across from Berth 307)	Construction/Maintenance Dredging	Berths were dredged to -20 feet
USACE Port of Portland	1962	Central Portion of Swan Island Lagoon; Rehandled from Lagoon to Mocks Landing.	370,445 ?	Mocks Landing - Old Kaiser Parking area and North of parking area	Rehandling	
USACE Port of Portland	1963–1964	Swan Island Basin	>1,400,000	Mocks Landing - Areas A–C	Rehandling	
Sea-Land Port of Portland	1963	Sea-Land Barge Basin, Swan Island Lagoon	12,000–15,766 ?	UNK	Construction Dredging	
USACE Port of Portland	1963	Near Entrance of Swan Island Basin	81,000 ?	Shipway end area (Lower end of Swan Island)	Dredging for fill	
Sea-Land Service Inc. Port of Portland	Sept 1965	Sea-Land Service Inc. Dock area	88,550–100,000 ?	Mocks Landing, Area C	Lagoon Deepening	This was done for vessel access to the Sealand Dock; dredge elevation proposed to -35' at the harbor line
Port of Portland USACE	1971	Willamette River channel at downstream end of Swan Island and entrance to Swan Island Lagoon	?	Port Center	Unknown - possibly channel deepening	Lagoon depth to be dredged was -35'
Port of Portland USACE US Navy	1972	Mouth of Swan Island Lagoon in front of U.S. Navy Site	235,527	Mocks Landing - Navy	Construction Dredging	
Port of Portland USACE	1973	Willamette River channel near Swan Island and possibly upstream end of Swan Island Lagoon (now filled land)	169,444 ?–225,981 ?	End of Swan Island Lagoon	Channel maintenance and possibly rehandling	
Port of Portland USACE DSL	1973	PSRY Berths 302 - 305	~2,500	End of Swan Island Lagoon	Emergency maintenance dredging	Dredging was required due to low water conditions that were present at that time; the depth needed to be -30 to accommodate vessels
Port of Portland Fred Devine (Marine Salvage Consortium) DSL USACE	1973–1974	Port Dredge Base	16,000–25,000	End of Swan Island Lagoon and Current Dredge Base Upland	Construction Dredging	Initial dredging was to -20'
Port of Portland USACE DSL	1976	Swan Island Lagoon upstream of Berth 308	<8,600	End of Swan Island Lagoon	Construction Dredging	
Fred Devine (Marine Salvage Consortium) Port of Portland	March–July 1979	Fred Devine Dockfront	<25,000	EOSIL	Construction and Maintenance Dredging	Dredging was to -10'

Attachment B

Table 1 - Swan Island Lagoon Dredging History

Parties Involved	Year	Dredged Area	Approx Volume (cubic yards)	Filled Area	Dredging Type	Dredge Depth (where available)
Fred Devine (Marine Salvage Consortium) Port of Portland	1984–1989	Fred Devine Dock	1,000 per year	UNK	Maintenance Dredging	Dredge depth permitted to -20'
Port of Portland U.S. Navy	1985	U.S. Navy Dock	18,000	UNK	Construction Dredging	Dredge depth was -30'
Port of Portland Unknown contractor	1985	Berths 301-305	23,700	End of Swan Island Lagoon	Maintenance Dredging	Dredging was to -33'
Port of Portland Eagle Elsner Inc. Benge Construction Co. Jackson Marine USACE	1986–1989	Boat Ramp Area in Swan Island Lagoon	200	Boat Ramp Area in Swan Island Lagoon	Construction Dredging	
Jackson Marine Port of Portland	1986	PSRY - Berths 306, 307, 308	1,200	EOSIL	Maintenance Dredging	
Port of Portland, City of Portland	1988	Swan Island Lagoon	290	End of Swan Island Lagoon	Construction Dredging (for outfall at the end of the lagoon)	
Port of Portland Eudaly Bros.	1991	Swan Island Boat Ramp	100	UNK	Erosion Control	

Swan Island SDU

Optimized Remedial Alternative

Attachment C

ATTACHMENT C
SWAN ISLAND LAGOON SEDIMENT STABILITY

Summary Statement: The physical stability of sediments in Swan Island Lagoon (SIL) indicates the permanence of in-place technologies (e.g., capping, *in situ* treatment, enhanced monitored natural recovery (ENR), and monitored natural recovery (MNR)) is comparable to removal technologies (e.g., dredging). Because sediments here are stable, in-place technologies such as MNR and ENR can provide permanent remedies meeting all aspects of the National Contingency Plan (NCP) short and long-term effectiveness criteria. Additional benefits of in-place technologies include reduced greenhouse gas emissions and reduced risks associated with the transport and handling of contaminated materials. Further, in-place technologies limit the release of contaminants during construction as compared to the unavoidable resuspension, dissolved releases, and residuals inherent to removal technologies.

1. **HYDRODYNAMIC CONDITIONS IN SWAN ISLAND ARE SUITABLE FOR IN-PLACE REMEDIAL TECHNOLOGIES**

   River currents are greatly attenuated in the quiescent off-channel SIL area, encouraging deposition and stimulating natural recovery processes.

   a. **Low Current Velocities**. Acoustic Doppler Current Profilers (ADCPs) were deployed in the Willamette River during three different higher-flow periods between 2002 and 2004 (*see* Appendix La to the Draft Feasibility Study [LWG Draft FS; Anchor QEA 2012]; DEA 2002). These data show relatively strong currents in the main channel of the Willamette River that generally ranged from 1 to 2 feet per second at the time of the surveys. The currents are strongest near the middle of the channel and decrease considerably near shore. Velocities measured at two locations within SIL were considerably lower (approximately 0.3 foot per second or lower). These measurements in SIL are consistent with ADCP measurements made in other off-channel areas of the Portland Harbor, such as the slips at Terminal 4 (BBL 2005).

   b. **Ongoing Sedimentation and Natural Recovery**. Relatively clean and fine-grained sediments from the main channel of the river tend to enter and deposit within SIL, contributing to ongoing natural recovery processes.

      i. **Fine-Grained Sediments**. Fine-grained sediments deposit and accumulate in quiescent areas. Based on a visual inspection of EPA Draft Final FS Figure 2.2-1, the majority of surface sediments in SIL have 60% or greater fines content and nearly half of the surface sediments in SIL have greater than 80% fines.

ii. **Sedimentation.** Based on bathymetric changes from 2003 to 2009 (LWG Draft FS Figure 2.1-2), the majority of SIL is net depositional. Specifically, the multi-beam bathymetry data collected over this period indicate the mudline has accreted over the first two-thirds of SIL by 7.5 to 15 cm (or more in some areas), while the remaining one-third further back in SIL had little to no discernable accretion. The EPA Draft Final FS Figure 3.4-19 shows similar conclusions.

iii. **Buried Contamination.** In an area that is depositional and in which known sources have been reduced over time, differences between surface and deep sediment concentrations can provide evidence that recovery is occurring, as newly depositing sediments with lower concentrations of contaminants deposit above the historical deposits with higher concentrations. For example, analysis of surface and subsurface sediment data in SIL shows that, on average, subsurface sediment polychlorinated biphenyls (PCBs) are higher by nearly a factor of two compared to surface sediments (*see* first bar on attached Figure 1).

iv. **Sediment Profile Image (SPI) Survey.** SPI surveys conducted in 2001 and 2013 provide an assessment of the succession (or maturity) of the benthic infaunal community at SIL (Striplin 2002; Germano 2014). Following a sediment disturbance, the benthic community will typically progress from Stage 1 (initial colonization by opportunistic and rapidly reproducing surface feeders) to Stage 3 (mature community with larger, slower growing, and more deeply burrowing organisms). The prevalence of Stage 3 communities at SIL provides another independent line of evidence for sediment stability.

1. In 2001, approximately 80% of the stations in the SIL SDU showed evidence of mature Stage 3 community structures, the only exception being the north corner of the lagoon. Across the entire study area, 46% of sampling locations showed evidence of mature Stage 3 community structures.
2. Following sampling in 2013 the percentage of mature Stage 3 community structures across the entire study area rose from 46% in 2001 to 71%, and of these Stage 3 sample location 80% remained Stage 3 from 2001 to 2013 providing evidence of persistent sediment stability over time. To the extent that benthic succession was encouraged by reduced contaminant stressors, this provides evidence of ongoing natural recovery.

2. POTENTIAL SEDIMENT DISTURBANCE MECHANISMS

Potential sediment disturbance mechanisms can be shown to have little or no likelihood of remobilizing surface or subsurface contaminants in SIL, as discussed in each of the following subsections.

a. **Extreme Flood Events**. SIL provides off-channel protection from main channel river currents, even during extreme flood events, because there is no flow-through. No flood scour was predicted by the model in SIL during the 1996 Spring Flood event due to low predicted shear stresses in this area (*see* Appendix La of the LWG Draft FS, Figures 3-3 and 3-4 and Figure 3.4-18 of the EPA Draft Final FS). Thus, extreme flood events are not likely to remobilize surface or subsurface contaminants.

b. **Propwash**. The evaluation of propwash potential conducted as part of the Draft FS (*see* Appendix C, Table C-20 of EPA Draft Final FS) found that the depth of sediment disturbance would normally be relatively shallow (less than 1 foot). Given this relatively shallow depth of disturbance, much of the buried contamination would not be disturbed by this process. And because current velocities are low in SIL (even during high-flow events), most of the sediments disturbed by propwash would redeposit back to the sediment bed at or near their initial location.

c. **Maintenance Dredging**. Model predictions and construction monitoring data show that suspended sediments can be well controlled during maintenance dredging in SIL with appropriate Best Management Practices and monitoring protocols. Further, where in-place technologies such as MNR are used to remediate contaminated sediments, maintenance dredging in most of SIL is relatively shallow. Such dredging will generally be disturbing more recent and less contaminated sediment layers to maintain existing navigation water depths and is unlikely to liberate older, buried contaminants. Further, the attached Figure 2 shows that current water depths in SIL are sufficient for navigation in much of the lagoon (this figure is provided as Figure 1 to the main document); given that considerable time has passed since navigational dredging was required in this area, it is anticipated that navigational dredging will not be needed in the future. If deeper sediments do require dredging to provide new and greater navigation depth, then the Oregon\Portland Sediment Evaluation Team process would ensure that any contaminated sediments were properly managed, and any newly exposed surface material would be as good as or better than the quality of existing surface sediments.

d. **In-Water Construction**. Regulatory programs are in place to control in-water construction activities and to ensure adequate environmental protections are employed to prevent the release of contaminants.

   i. **Portland Harbor Interagency Permit Coordination Team.** A team, consisting of EPA, USACE, DEQ, DSL, and NOAA reviews all proposed in-water permitting projects within and upstream of the Portland Harbor, including the Downtown Reach.

   ii. **Portland Sediment Evaluation Team.** This team, consisting of USACE, EPA, DEQ, DSL, and NOAA, reviews all dredging projects in the Portland District in accordance with the Sediment Evaluation Framework for the Pacific Northwest (USACE et al. 2009).

e. **Earthquakes**. Ash Creek Associates completed a detailed assessment of the seismic environment as part of the Terminal 4 Confined Disposal Facility 60% Design Study (2011). This analysis included "mega thrust" earthquakes along the Cascadia Subduction Zone and shallower crustal earthquakes along known or hypothetical faults. Existing site-specific geotechnical data at SIL have not been studied in detail. However, the subsurface conditions are expected to be similar in nature to other areas of the river.

   i. **Deformation of Waterway Floors**. Recent surface sediments, some of which may be contaminated, and the upper layers of underlying river alluvium may be subject to liquefaction during an earthquake. However, SIL contaminants are concentrated on relatively flat waterway floors where there is little or no gravitational driving force to displace them. As a result, there may be isolated areas of settlement and movement, but sediments should not move far from their original location within the SIL and should not be released to the main river channel.

   ii. **Deformation of Sediment Caps**. If SIL sediments were capped, the caps could be susceptible to liquefaction under certain seismic events, and similar responses are anticipated. On the relatively flat waterway floors, some cap thinning may occur due to consolidation after liquefaction or lateral cap movement. However, deformed or damaged caps could be easily repaired after the event.

   iii. **Deformation of SIL Sidewall**. If impacted sediments are identified on adjacent banks, sidewall slopes of 50% (2 horizontal to 1 vertical) or steeper may be present. If liquefaction were to occur on these slopes, runout of the impacted sediment further into the SIL would be anticipated. Runout into the river is unlikely but would need to be further assessed in detail. Engineering measures, such as a cap and rock buttress at the toe of the cap area, would likely reduce the runout of impacted sediment.

3. REFERENCES

Anchor QEA, 2012. Appendix La – Sediment Transport Modeling, In *Portland Harbor Draft Feasibility Study*. Lower Willamette Group. March 30, 2012.

Ash Creek, 2011. Updated Preliminary Seismic and Geotechnical Evaluations, Terminal 4, Slip 1 CDF, Portland, Oregon. Prepared by Stuart Albright, P.E., and Stephen Dickenson, P.E. August 3, 2011.

BBL (Blasland, Bouck, and Lee), 2005. Terminal 4 Early Action EE/CA Report. Port of Portland. May 31, 2005.

DEA (David Evans and Associates, Inc.), 2002. Willamette River Acoustic Doppler Current Profiler Survey Results. June 2002.

Germano (Germano and Associates), 2014. Characterization of the Lower Willamette River with Sediment Profile Imaging: Changes in Time and Space. Prepared for de Maximus, Inc. June 2014.

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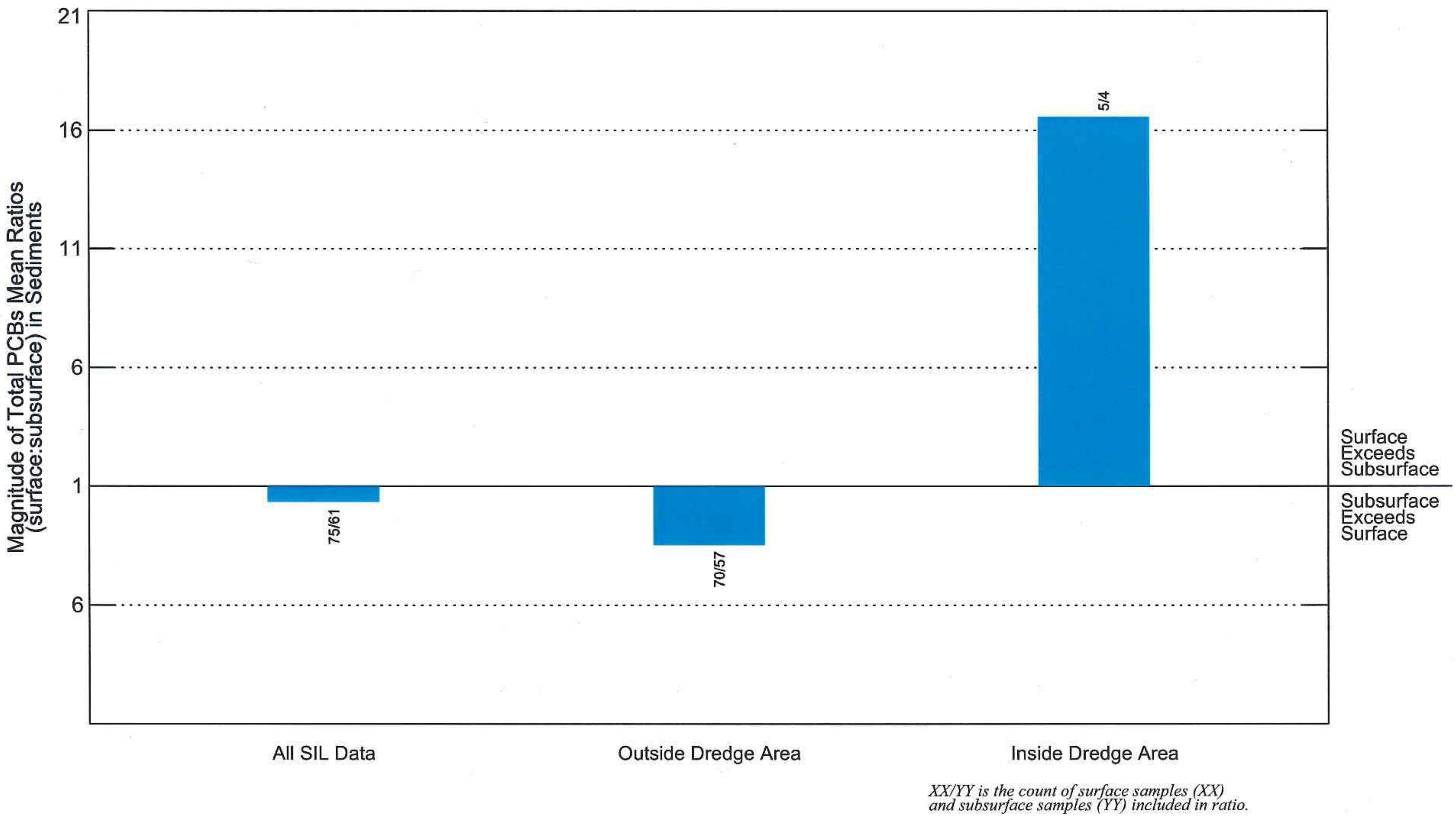


Figure 1

Portland Harbor RI/FS

Total PCBs Mean Surface/Subsurface Concentration Ratios in Swan Island Lagoon Sediment

Swan Island SDU

Optimized Remedial Alternative

Attachment D

Attachment D
Effectiveness Evaluation for Enhanced Monitored Natural Recovery

Purpose and Scope:

Enhanced Monitored Natural Recovery (ENR) is an important part of the U.S. Environmental Protection Agency (EPA) Preferred Alternative I (EPA 2016a) and the Swan Island Sediment Decision Unit (SI SDU) Optimized Alternative. EPA stated in the Feasibility Study (EPA 2016b) (FS) that ENR is an effective technology for reducing exposure from PCBs and attaining Preliminary Remediation Goals (PRGs) in the SI SDU. In the technology assignment process, EPA identified ENR for areas within Remedial Action Level (RAL) footprints that contain "Principal Threat Waste," but are not addressed by either dredging or engineered cap.

However, EPA did not account for the effect of ENR on Surface Weighted Average Concentrations (SWACs) in the SI SDU. For the Preferred Alternative I, EPA did not prescribe ENR in areas with PCB concentrations above the 200 ug/kg RAL. The Optimized Alternative allows for ENR in areas of sediment with PCB concentrations greater than the RAL. The analysis presented herein is intended to assess the potential effectiveness of an ENR layer using the same tool that EPA used to evaluate cap effectiveness and in the PTW analysis to determine whether PCBs in Portland Harbor could be reliably contained. The tool is the "Steady-State Cap Design Model" (Version 1.19) based on Lampert and Reible (2009).

Input Variables and Analysis:

The steady-state conditions version of the model for passive caps was used to evaluate tetra-chlorine polychlorinated biphenyl homologs, which is the same analyte group used by EPA in the PTW analysis to identify concentrations that are "reliably contained" (Appendix D, EPA 2016). Model input and output variables are shown in Table 1. Default values for model parameters were used except:

a. Octanol-water partition coefficient, log K_{ow} = 6.6 (*the same value as used by EPA).*
b. Contaminant Pore Water Concentration, C_0 = variable, see below.
c. Organic Carbon Concentration in Bioactive zone of Sediments, $(f_{oc})_{bio}$ = 1.5% (approximate site average).
d. Conventional Cap placed depth = 30 cm (*this is the thickness of the ENR layer cited by EPA for the preferred alternative*).
e. Pore water Concentration at Depth, $C_{(z)}$ = variable (*this is the concentration cited by EPA as the goal for cap pore water, and is the PRG for PCBs for Remedial Action Objective 8).*

Other input parameter values were the same as used by EPA. The model run was conducted by changing the parameter C_0 until the C(z) was equal to or less than the 0.014 ug/L, which is the goal cited by EPA in Appendix D (Table D7-7) and is the PRG for PCBs for Remedial Action Objective 8 (RAO8).

The value for contaminant pore water PCB concentration ($C_{(z)}$) was converted to bulk sediment concentration (C_{sed}) using equilibrium partitioning assumptions (EPA 2003), as shown in Table 2.

Results:

Based on this analysis, the concentration of (tetra) PCBs in the pore water of the ENR layer would not exceed the RAO8 PRG unless PCB concentration exceeded about 1,200 ug/kg in the bulk sediment underlying the ENR layer.

References Cited:

Lampert, D.J. and Reible, D.D. 2009. An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments. Soil & Sediment Contamination, 2009, 18(4):470-*488.*

EPA (US Environmental Protection Agency). 2003. Technical basis for the derivation of equilibrium partitioning sediment benchmarks (ESBs) for the protection of benthic organisms: Nonionic organics. EPA-600-R-02-014. Office of Research and Development. Washington, DC. (draft)

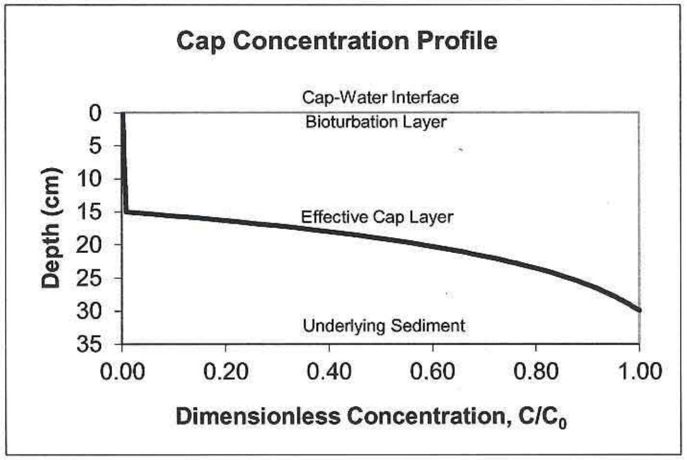
EPA (US Environmental Protection Agency). 2016a. Portland Harbor Superfund Site. Superfund Proposed Plan. USEPA Region 10. June.

EPA (US Environmental Protection Agency). 2016b. Portland Harbor RI/FS, Feasibility Study. USEPA Region 10. June.

Table 1. Model Structure and Input Variables

STEADY-STATE CAP DESIGN MODEL
from Lampert and Reible (2009)*
Version 1.19
6/8/2012

Instructions: This spreadsheet determines concentrations and fluxes in a sediment cap at steady-state, assuming advection, diffusion, dispersion, bioturbation, deposition/erosion, sorption onto colloidal organic matter, and boundary layer mass transfer. The deposition velocity is negative in the case of erosion, and is assumed to be constant and to have minimal effect on the thickness of the cap. The cells in GREEN are input cells; these can be changed for the design of interest. Cells in YELLOW are commonly used parameter estimates. These can be changed but note that physically unrealistic parameter values may result. A second worksheet calculates the transient profiles for a semi-infinite case. DO NOT CHANGE THE CELLS IN RED (or the spreadsheet will not function properly). These are calculated values for model outputs. The third worksheet title "array" allows the user to create an array of outputs for a given input (e.g., to study different compounds for a given site).



Contaminant Properties

Contaminant	EPA value for Tetra PCB homologs		
Octanol-water partition coefficient, log K_{ow}	6.6		
Water Diffusivity, D_w	6.0E-06	cm^2/s	
Cap Decay Rate, λ_1	0.00	yr^{-1}	
Bioturbation Layer Decay Rate, λ_2	0.00	yr^{-1}	

Sediment Properties

Contaminant Pore Water Concentration, C_0	1.6	ug/L	Vary this value until cell C(z) is below critical value (RAO 8 = 0.014 ug/L)
Biological Active Zone fraction organic carbon, $(f_{oc})_{bio}$	0.015		
Colloidal Organic Carbon Concentration, ρ_{DOC}	0	mg/L	
Darcy Velocity, V (positive is upwelling)	10	cm/yr	
Depositional Velocity, V_{dep} *(positive is deposition of sediments)*	0	cm/yr	
Bioturbation Layer Thickness, h_{bio}	15	cm	
Pore Water Biodiffusion Coefficient, D_{bio}^{pw}	100	cm^2/yr	
Particle Biodiffusion Coefficient, D_{bio}^{p}	1	cm^2/yr	

Cap Properties

Conventional Cap placed depth	30	cm	Represents a one-foot sand layer equivalent to ENR
Cap Materials -Granular (G) or Consolidated Silty/Clay (C)	G		
Cap consolidation depth	0	cm	
Underlying sediment consolidation due to cap placement	15	cm	
Porosity, ε	0.4		

Table 1. Model Structure and Input Variables

Particle Density, ρ_P	2.6	g/cm^3	
fraction organic carbon, $(f_{oc})_{eff}$	0.0006		
Depth of Interest, z	15	cm	
Fraction organic carbon at depth of interest, $f_{oc}(z)$	0.0006		
Commonly Used Parameter Estimates			
Organic Carbon Partition Coefficient, log K_{oc}	6.05	log L/kg	
Colloidal Organic Carbon Partition Coefficient, log K_{DOC}	5.68	log L/kg	
Boundary Layer Mass Transfer Coefficient, k_{bl}	0.75	cm/hr	
Dispersivity, α	1.50	cm	(not allowed to be less than 1 cm)
Effective Cap Layer Diffusion/Dispersion Coeff., D_1	71	cm^2/yr	
Bioturbation Layer Diffusion/Dispersion Coeff., D_2	26657	cm^2/yr	
Output			
Pore Water Concentration at Depth, $C(z)$	0.013	ug/L	This value needs to be under 0.014 ug/L (EPA FS Table D7-7)
Loading at Depth, $W(z)$	8.8	ug/kg	
Average Bioturbation Layer Loading, $(W_{bio})_{avg}$	134	ug/kg	
Flux to Overlying Water Column, J	182	ug/m^2/yr	
Cap-Bioturbation Interface Concentration, C_{bio}/C_0, C_{bio}	0.81%		
Cap-Water Interface Concentration, C_{bl}/C_0, C_{bl}	0.17%		
Average Bioturbation Concentration, $(C_{bio})_{avg}/C_0$, $(C_{bio})_{avg}$	0.49%		
Characteristic Time to~1% of steady state, $t_{adv/diff}$	185.7	yr	
Dimensionless Parameters			
Effective Cap Layer Peclet No., Pe_1	2.12		
Effective Cap Layer Damkohler No., Da_1	0.00		
β = SQRT($Pe_1{}^2/4+Da_1$)	1.06		
Bioturbation Layer Peclet No., Pe_2	0.01		
Bioturbation Layer Damkohler No., Da_2	0.00		
γ = SQRT($Pe_2{}^2/4+Da_2$)	0.004		
Sherwood Number at Interface, Sh	3.7		
Other Parameters			
Cap final thickness, h_{cap}	29.99	cm	
Cap Effective thickness w/ot bioturbation layer, h_{eff}	15	cm	
Containment Layer Retardation Factor, R_1	1060		
Bioturbation Layer Retardation Factor, R_2	26486		

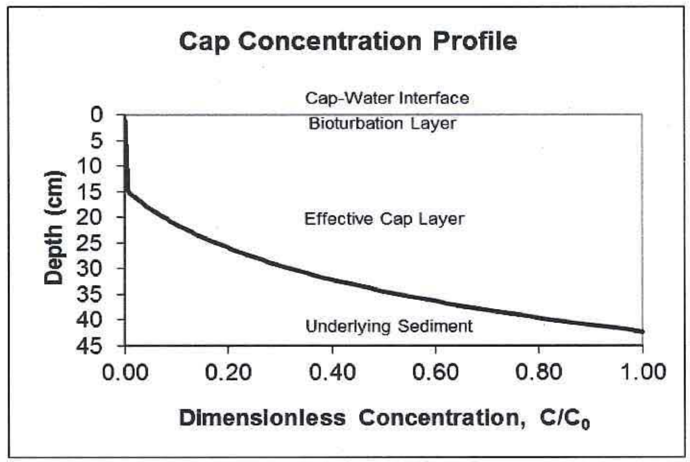


Table 1. Model Structure and Input Variables

Effective Advective Velocity, U	10.00	cm/yr	(not allowed to be more negative than that which will offset diffusion)
Characteristic Advection Time-cap layer, t_{adv}	1588.3	yr	
Characteristic Diffusion Time-cap layer, t_{diff}	210.2	yr	
Characteristic Reaction Time-cap layer, t_{decay}	infinity	yr	

*Lampert, D.J. and Reible, D.D. 2009. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination, 2009, 18(4):470-488.

Table 2. Calculation of PCB concentration in Sediment Underling ENR that would result in Cap porewater PCB equal to RAO 8 PRG.

Equation: Csed = C(z) *(Koc*foc) [based on EPA 2003]

Param	Description	Value	Units	Source
Input parameters				
C(z)	Concentration of PCB in sediment porewater underlying the cap that results in 0.014 ug/L in pore water of cap.	1.6	ug/L	Steady state estimate from Reible cap model (see Cells B45 and B16 in Tab: Steady State Conditions)
Koc	Organic C - water partition coefficient.	78,100	L/kg	Value for PCB77 cited by EPA in 2016 FS
foc	Fraction of bulk sediment that is organic carbon	0.01		estimate for ENR layer carbon content
Output				
Csed	Concentration in Sediment that results in pore water conc. equal to RAO 8 PRG	1,250	ug/kg	This represents estimate of Sediment concentration that would be successfully contained by a 1-foot sand layer.